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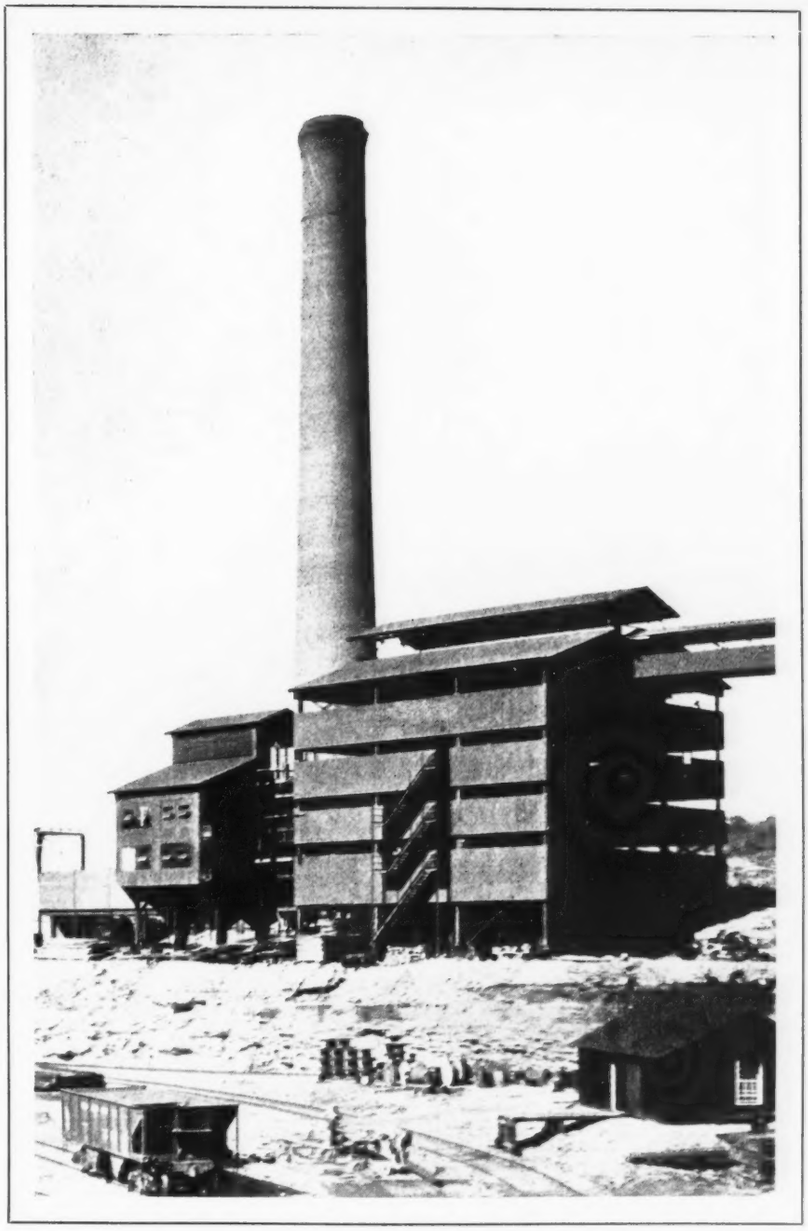


Stack and roaster building of Magma Copper Co.'s new smelter at Superior, Ariz.

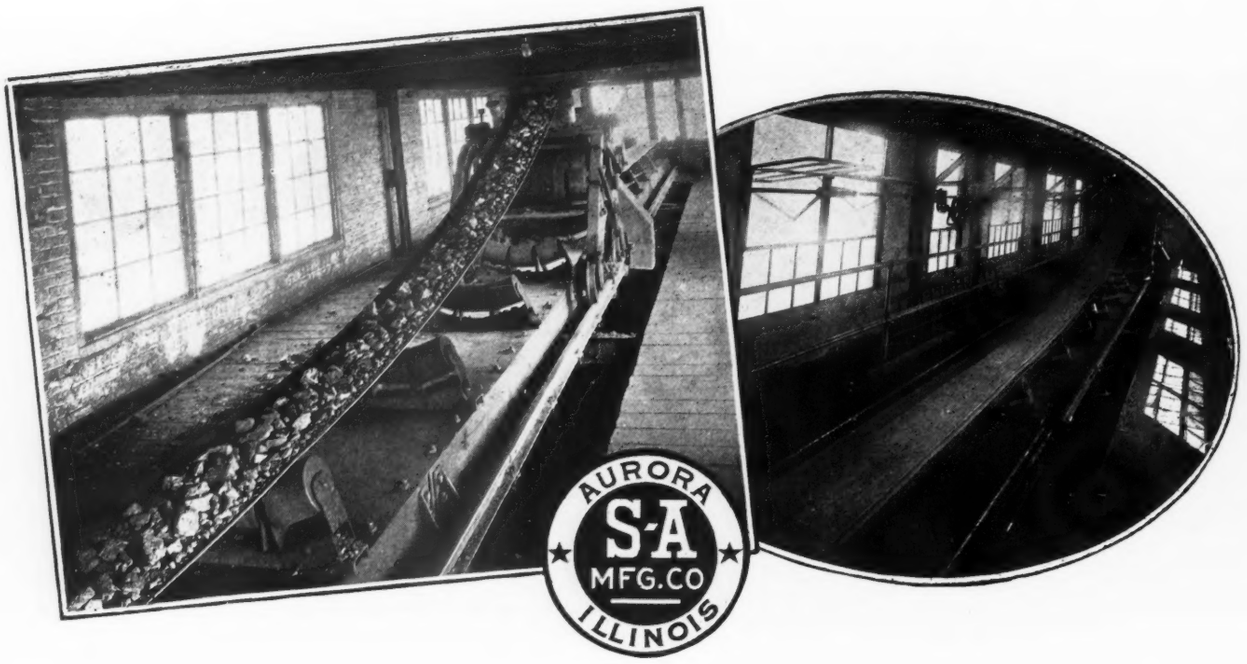
Engineering Details of the New Magma Copper Smelter

By H. A. Ruth

Marketing of Vanadium Ores and Metal

By Frank L. Hess

Biography of George D. Van Arsdale



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ENGINEERING AND
MINING JOURNAL-PRESS

JOSIAH EDWARD SPURR, Editor

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Ore Manufacturing, and the Byproducts

WITH THE RAPID DEPLETION of the richer metallic ores, which has been going on steadily for the last fifty years in the United States, new methods, machines, and processes have been devised for working lower-grade ores at a profit. In spite of the rise in the commodity index of prices, and hence of the cost of the items consumed in mining operations, this lowering of the grade of the ore mined seems a progressive process, to which no limit can be set. The limit is whittled down to a fine point, but it gets continually finer.

What we would have dismissed as ridiculous fifteen years ago is now more than fulfilled. We imagined that 2 per cent copper ore could never be worked: now we mine at a profit ore containing less than 1 per cent. And in one mine—the Alaska Juneau—gold ore carrying 81c. gold per ton is mined with a margin of profit; and from placer gravels at various places gold in the infinitesimal quantity of 10c. or less per cubic yard is recovered as a business undertaking.

All this is explained by the statement that mining and metal recovery is more and more a manufacturing business, and will more and more develop in that line; and, being a manufacturing business, an element enters which was formerly foreign—the element of competition with other mines, which are manufacturers of the same products. This is seen in the copper situation, where the manufacturers whose cost is less have crowded to the wall those whose costs are higher. Competition involves two chief elements—cost of production and skill in marketing the product. Business sagacity more and more commands a premium in mining enterprises, and more and more takes command of and directs technical skill.

Skillful management will more and more prescribe, as a condition of successful competition and that survival of the fittest which is already clearly ordained as applying hardly less to mining operations than to manufacturing operations, that nothing shall be wasted. When the ores were richer, the finding and the possession of a mine was the whole thing—a golden era whose extreme is still reflected in the "movie" plays. That was the epoch when a successful operator made the famous expression of contempt for "a mine that would not stand bad management." Those days are gone forever. The manager must be a prodigy of thrift and acumen if he and his mine are to survive. So the days when zinc and arsenic and the rarer metals were wasted on the desert air have passed, or are passing. And eventually the triumph of the successful pork packer, who boasts that "everything of the pig is utilized except the squeal," will come true of the mine which has survived its competitors.

Slag dumps are in many places now being utilized for road-building metal; and, indeed, any hard-rock dump may be valuable for that purpose, depending on the location. Rock dumps may have many other commercial uses, and it is the job of the manager to discover those uses and then to sell the idea—to successfully market the byproduct.

The use of finely ground mine waste as a fertilizer is one of the things which will probably further develop. The American Zinc Company, of Tennessee, which mines a 2 to 3 per cent zinc ore in dolomite, has installed a large plant for handling its dolomite waste and marketing it as "agricultural lime." So successful has this been that it is reported that 1 per cent zinc ore has been thus handled at a profit; and it is also reported that the management looks forward to the probability of handling "zinc" ore containing no zinc at all! This is the fine edge of efficiency, and shows how low the grade of ores may theoretically become, and still be mined. Some day we shall mine the rocks and reduce them, and sell their component elements; as we recently have come to mine the air for the same purpose. In the Mascot instance skill of marketing is no less essential than the skill of operation; for at the Tennessee marble quarries, not far away, where there is much dolomite waste, they are not using this waste, stating that Mascot controls the agricultural lime market!

On page 701 of this issue we print a letter from a correspondent in Oregon who cites an experiment which showed that sulphur is a great fertilizer and that finely ground pyrites provides sulphur available to soils. We are making inquiries regarding this. It is likely that many mine dumps, finely ground, might be marketed as fertilizer. The subject is worthy of investigation. The dumps from the Cripple Creek mills contain enough potash so that during the war they were investigated by the Bureau of Mines, with a view of recovering the element.

Many valuable elements in rocks become at least moderately available to soils through fine grinding alone; hence it may be that certain slimes from our fine-grinding mills may have a market value as they stand—dependent, of course, on close proximity to an agricultural country whose soil needs the elements which the slimes contain.

Mesabi Iron Co. and the Iron-Ore Situation

FROM VARIOUS SOURCES inquiries have come to us regarding the present position of the Mesabi Iron Co., the big enterprise based on the exploitation of low-grade magnetite ores on the eastern end of the Mesabi range in Minnesota. The plant for crushing, concentrating, and sintering the ore, after alterations had been nearly completed to increase the capacity to 2,500 tons of ore or 800 tons of sinter per day, was shut down last spring. At that time the nominal base price of $6.45 per ton for "Old Range Bessemer" at Lake Erie points was cut 80c. by marketing agencies. As a matter of fact, a large proportion of the ore sold during the season was settled for on a much lower basis.

Although the Mesabi Iron Co. obtains a substantial

premium on its product, it must compete in the open market with the lower-grade ores from the western Mesabi and the other iron-ore ranges. The shutdown last spring was not entirely the consequence of the price cut. The question of being able to dispose of the product at all was a factor. The ore movement during the last season has been made up almost entirely of three classes: shipments made by the U. S. Steel Corporation, shipments under long-term contracts to independent furnaces, and shipments under partnership operating agreements, also to "independents." There has not been, nor is there now, any real open market.

Some operators predicted that the exceedingly dull season up to Oct. 1 would be followed by a rush to build up stocks at the blast-furnace plants before navigation closes. Instead of this, even the Steel Corporation recently cut down its requirements, and shipping virtually will cease by Nov. 1. The forecast of the situation, on which the Mesabi Iron Co. based its decision to suspend operations, seems to have been entirely sound.

About half of the iron mines in the Lake Superior region have been idle this year, so that the situation of the Mesabi company, as an independent producer, follows the rule, not the exception. In some respects the company enjoys a decided advantage over many other producers. As its mine is an open-cut operation, it has no pumping to do and no underground workings to keep open. Unlike some others, it has no royalties to pay when not producing. Another favorable circumstance is that the members of the former operating staff are temporarily placed at other Jackling-Hayden Stone properties and that they can be recalled on short notice when resumption is decided upon. Inactivity of a pioneer enterprise is not pleasant for the shareholders, but the outlook for Mesabi Iron is by no means gloomy.

Bright Angel Trail Leads Both Up and Down

NEWSPAPER DISPATCHES chronicle the fact that the United States District Court at Tucson, Ariz., has ordered United States Senator Ralph H. Cameron, of Arizona, to obey the decree of the Federal Court issued several years ago and to remove all his belongings, employees, and property from the Bright Angel Trail, which winds its way down into the Grand Canyon of Arizona. A news item by J. E. Mitchell, of Phoenix, says:

"The history of the battle over possession of the trail is as long and winding as the trail itself. Nearly a generation ago Senator Cameron, then a poor miner and cow hand, acquired the rights of the first constructors of the trail. The Santa Fe railroad opposed Cameron's rights, insisting the present entrance to the trail was not the original one. Others considered they had as good a right to the trail as did Cameron.

"Trails cannot be owned outright in Arizona. Cameron's franchise recently expired.

"With the Bright Angel Trail in the hands of Coconino County at last, negotiations were opened up by the Federal Government for its purchase as a part of the national park. Congress allocated $100,000 for the purchase. But first Cameron must be ousted."

A phase of the situation not referred to in this article, but of especial interest to miners, is that Cameron located mining claims covering the entrance to the Bright Angel Trail, and for years alleged that the sandstone contained profitable quantities of platinum. The story of the repeated claims and repeated investigations by mining companies and others of this supposedly very rich platinum mine would be long, intricate, and absorbing. Platinum assays were to be had to be sure, and were certified to by reputable assayers—but no ore, in the quantity sense. A prominent dental-supply company was among the would-be investors who found that they could get enough "ore" for assay that showed real platinum, but not enough "ore" for a mill test. Yet the mine was hawked about by various avid promoters from pillar to post, for years. A prominent geologist was employed by Cameron to report on the property; but he refused to publicly commit himself after the examination. Certainly the occurrence of platinum in any quantity in unaltered sandstone would have been an anomaly; and there were those who suggested that the ashes from platinum prints (the holders of the trail did much in the way of photography) might have become carelessly scattered around, and contaminated the sandstone samples so as to show sporadic platinum assays.

Do Your Voting

ON NOV. 4 the most important election in which a citizen of the United States has the privilege of voting takes place. The policy and personnel of the Federal Government are on that day decreed by the vote of the sovereign citizens assembled. It is the privilege and also the duty of each eligible citizen to cast his vote. There is just at present going on a definite form of advertising propaganda to induce the citizen to cast his vote—no matter how he casts it. It is pointed out that in 1870, 80 per cent of the electorate cast a ballot; in 1920, 49 per cent. According to statistics, 27,635,074 potential voters did not vote in the 1920 Presidential race!

Is it not curious that the right of self-government, the badge and principle of democracy, which was fought for through so many bloody centuries, for which patriots gave their lives and have been revered as martyrs, should be in the way of being disregarded like a worn toy? The job and problem of the party leaders is to "get the voters to the polls"—a great mass of those who do vote are chivvied to the booths reluctantly. In a certain section of the country where we were recently, it was told that the voters of the countryside had grown to expect a dollar or two on Election Day—not to buy their vote—but to compensate them for time lost at their work; and that as this would probably not happen this year, the total vote would be light. The voter of this type imagines he is conferring a favor on somebody by voting: like the small child when he discovers that eating his dinner pleases his mother, and therefore starves himself as a show of independence.

But the vote slacker—the foe of democracy—is not confined to this hard-laboring class. He is, as has often been remarked, as characteristic of the white-collared and more schooled elements. These as well as the rank and file take little part or interest in politics, which is the machinery of government; and voting is a matter of little interest. The mining engineer is no exception—democracy is a conception that he considers no more attentively than he does phlebotomy, or anything else that he does not understand or worry about. He does not vote in many of his own professional organizations; the ballot has been denied him; and he does not care. Why should he be more interested in voting as a citizen of the Republic?

Here is a swift tendency that means something very definite. It is certain that the citizen of Rome who was

contemporaneous with the downfall of the Roman Empire had no conception of what was going on. It was a relatively slow process, and he was occupied with earning his living, with his pleasures and his ambitions. The coming and passing of the Dark Ages was invisible to the men who trod the stage in successive relays. Only to historians, looking back through the centuries, are these tremendous changes visible and clear-cut.

Perspective is necessary to clear vision. Have we progressed in intelligence, so that we may mark the drift of changing times, far more swift now than in the by-gone centuries? We may mark in a hundred years the change from an agricultural to an industrial country; the change from the typical American who was an independent land owner and farmer to the typical American who is an employee of some industrial organization; we may note the ever-increasing complexity of economic organizations and that the individual is chiefly or wholly concerned as to his place in such organizations. Only economic topics are of interest; only the pocketbook nerve is sensitive and reactive. The typical American is not interested in his rights and duties as a sovereign citizen. He aspires not to rule, but to be coddled—to be ruled, in short, but benevolently.

The mining engineer, again, is no exception; he is no malcontent; he does not desire to rule or to vote—if we judge him by his professional organizations; but he wants to be given a job, treated kindly, and fed regularly. Individually he is charming, and efficient in his work; collectively he is not a force.

If this tendency to slough off democracy continues—if professionals continue to govern more and more unhampered—what of the future? We leave it with the question; but evidently we are living in a period of tremendous change, when the social and political aspect of the country, as well as of the rest of the world, is swiftly changing, with results that will be revolutionary.

Meanwhile, brother mining men—vote! Get out on Nov. 4 and vote. Furthermore, vote everywhere, in any cause, if you are entitled to vote. You are morally bound to vote in any matter that touches you personally.

The Business Outlook

THE BELIEF that business conditions are on the upgrade, which we quoted editorially in our issue of Sept. 6, still seems to prevail. Undoubtedly, most people are disposed so far as possible to postpone their business commitments till the result of the election is shown. Nevertheless, the economic trend is independently growing better. The National Bank of Commerce of New York observes (Oct. 20): "Business is gaining, in spite of somewhat irregular progress in the past month." And the National Industrial Conference Board says (Oct. 23): "Everything points to a slow but steady improvement in industry. The latest survey of wages, hours, and employment in twenty-three leading manufacturing industries, covering the month of August, shows a definite upward tendency in the number employed and in the average of hours per week per wage earner. . . . Further evidence that industrial conditions are improving is found in a summary of wage changes throughout the United States during the month ending Oct. 14 made by the board, which reveals forty increases and six reductions."

The demand for the principal metals is also healthy and increasing, as we have reported in our market pages. And the general business symptoms above cited indicate that the demand for the metals by the consumer is likely to be a broadening one. Granted an outcome of the Presidential election which assures the manufacturer and the banker, there is no doubt that the consumption of the metals will gradually increase.

The Raccoon Mountains in Alabama

IN OUR ISSUE OF JULY 5 we commented on the story told in a speech made by D. E. Mitchell before a gathering of influential citizens of St. Louis in which he described enormous deposits of coal and iron in the Raccoon Mountain district (of northeastern Alabama) and prophesied that as a result of these hitherto unknown deposits St. Louis would outstrip Pittsburgh as a steel center. The talk was convincing and pleasing to the influential citizens of St. Louis, and Mr. Mitchell's address was printed in full in *America at Work*, a reputable magazine published in St. Louis. After our satirical editorial on the subject, which was based upon reliable information, the editor of *America at Work* wrote Mr. Mitchell, calling his attention to our editorial and published his answer, which was in part as follows:

"The data secured by the several corporations covering the north Alabama district belongs to them and cannot be given out by me without their consent. I have taken up the matter with a number of the owners (including some of the leading financiers of the country). They have called my attention to a series of recent articles reflecting on the value of mineral deposits in northern Alabama, particularly belittling the iron ore deposit.

"We know that we have the purest quality of coal in the nation. We know we have the largest iron ore deposit of the country. We have decided on a formal method of scientific and ethical refutation of the campaign of misrepresentation and satire. We have decided to have the leading engineer of the state present the facts to the Mining Congress which meets in Birmingham during the month of September. We will entertain the entire Mining Congress on an inspection tour of the northern Alabama district, so the entire public will have the facts in the official record of the Mining Congress."

It was with considerable interest, therefore, that at the meeting of the American Institute of Mining and Metallurgical Engineers at Birmingham, in October, the appearance of Mr. Mitchell was expected—first, to learn more about the northern Alabama ore reserves; second, with curiosity to see who was the leading engineer of Alabama. The fact that Mr. Mitchell referred to the American Institute meeting in October as an American Mining Congress meeting in September, in his letter, was noted in passing; and its significance duly tabulated. But Mr. Mitchell disappointed expectations, and did not carry out his announced program.

From many sources, however, information was culled which demonstrated that our comment on Mr. Mitchell's speech was wholesome and necessary. While the Clinton iron-bearing formation exists in the region he has so glowingly described, actual tests, chiefly by bore hole, are reliably reported as having been to date few, and the results mainly negative. There appears to have been no justification for a stock boom or any other type of excitement. The kindly suggestion was made that Mr. Mitchell possesses a lively imagination, and saw possibilities in the field beyond what was in any way warranted by the known facts. When further facts are available, it will be time to make another speech.

There is a great future ahead for the iron and coal industry of the South; but enthusiasm should go forward only step by step with the facts.

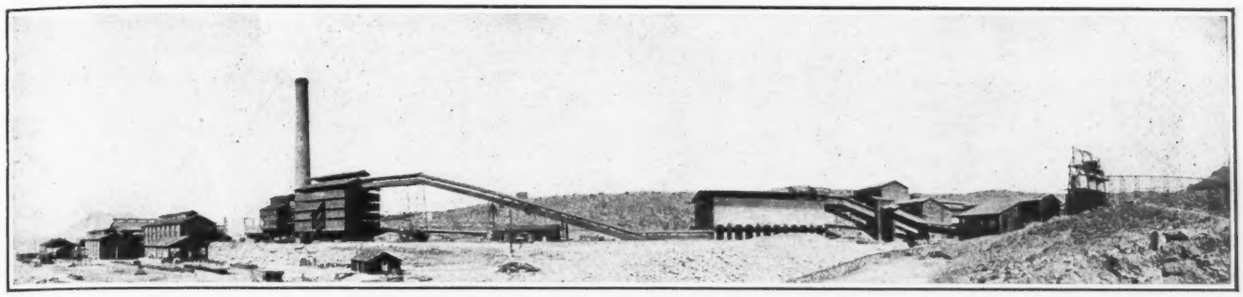
Metallurgists of Note

George Dawes Van Arsdale

THE FUTURE OF THE COPPER INDUSTRY in the United States and successful competition with foreign metal depend to a considerable extent on large-scale operation and low-cost methods of beneficiation, prominent among which are the various applications of the fundamentals of leaching practice, coupled with intensive chemical research. The retention as consulting engineer of George D. Van Arsdale by the Inspiration Consolidated Copper Co., in connection with the scheme of treatment to be adopted in the leaching plant now under consideration by that corporation, affords opportunity for a brief biography of a prominent American metallurgist. Van Arsdale was born in 1874 at Newark, N. J., and is of Dutch - English descent. He was graduated from Princeton in 1896, becoming chemist to Phelps, Dodge & Co. in 1899, later known as the Phelps Dodge Corporation, on the staff of which he was subsequently appointed consulting chemist and head of the research department. Dr. James Douglas, late president of the corporation, was one of the leading pioneer copper hydrometallurgists of this country. Consequently, research under his direction was directed to the study of wet methods, and much work was done on various modifications of what were known as the Hunt and Douglas methods. After a visit to Rio Tinto, Dr. Douglas became interested in heap leaching, and experiments were started at Bisbee. The precise chemistry of the method was not then known, and later recognition of the rôle played by iron salts led to large-scale research, and to the erection of a plant for treating, by heap leaching, the low-grade ores from Sacramento Hill. Research of the character recently followed by the U. S. Bureau of Mines on the production of acid by the wet oxidation of sulphur dioxide was modified by using the gas under pressure, resulting in the discovery in 1903 of the now well-known sulphur-dioxide method of precipitating the copper. Electrolytic methods were then investigated, the result being the elimination of the bugbear of foul solutions. Moreover, electrolytic methods then possessed the disadvantage of the handicap that no commercial anode was known capable of resisting disintegration; and the discovery was then made that anodic depolarizing agents not only had the effect of reducing voltage, but also prevented disintegration. Thus was the anode problem solved, permitting the use of lead or graphite. Large-scale leaching tests were made at Douglas for the Phelps Dodge Corporation, using sulphur dioxide as an agent for depolarizing and for the control of ferric iron; and a similar method was later tested by the engineers of the New Cornelia Copper Co. and adopted for use at the Ajo plant. More recently, an extended series of tests for the Inspiration Consolidated Copper Co. has resulted in an apparent solution of their mixed-ore problem, and a plant embodying the results of this work is being designed. Fortunately, the advance in engineering, the application of metallurgical principles, and the spending of money by the larger companies for research on leaching have brought about such noteworthy results that this process of extraction has now almost reached the stage of being considered a standard method of beneficiation. Leaching, under experienced direction, may be expected to yield high recoveries, and, under favorable conditions, at lower costs than by other methods. The work done by Van Arsdale and other metallurgists in the last twenty-five years has resulted in the development of a chemico-metallurgical technique in the treatment of copper ores, from which selection can be made and methods formulated for the solution of problems that, a few years ago, were thought to present insurmountable difficulties. The ultimate development of hydro-electric power on a large scale in the Southwest is a foregone conclusion; and in this region at least it is probable that leaching practice for the extraction of the copper will continue to be associated with electrolytic methods for its recovery.

GEORGE DAWES VAN ARSDALE

Mr. Van Arsdale is a member of the Institute, of the Mining and Metallurgical Society of America, and of the American Electrochemical Society. His headquarters are at Los Angeles.



General view of new Magma Copper smelter

The New Magma Copper Smelter

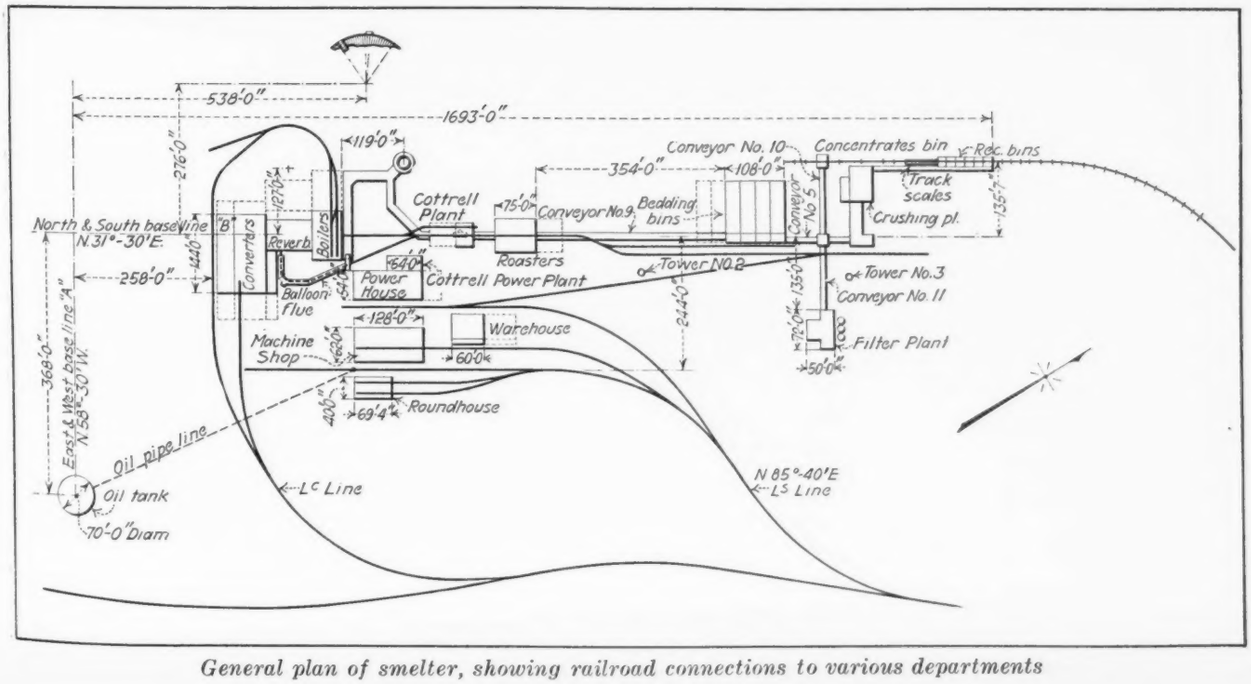
Engineering Details of Model Installation in Arizona Equipped with Latest Features of Modern Smelting Practice

By H. A. Ruth
Engineer, Bradley, Bruff & Labarthe, San Francisco

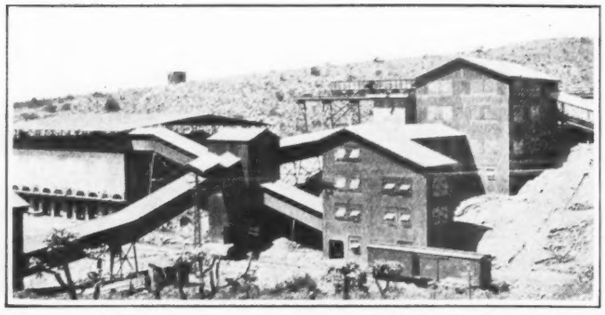
THE NEW SMELTER of the Magma Copper Co., near Superior, Ariz., is about 4,000 ft. by rail from the company's concentrating plant. A standard-gage railroad, connecting the mill and smelter properties with the Arizona Eastern R.R. at Magma Junction, was formerly narrow-gage, but was standardized as part of the construction program of the smelter. The plant is designed for treating flotation and table concentrates, direct-smelting ores, custom ores, and concentrates. The new material being treated under normal conditions consists of about 100 tons each of table and flotation concentrates, 150 tons of crushed ore, 54 tons of limestone, and 42 tons of converter flux per day.

The present site was selected as being the most favorable for co-ordinating the various smelter departments, for the transportation of ores and concentrates from the mine and mill, and as providing ample space for the disposition of slag. The general arrangement of the smelter is shown in the accompanying plan. The main yard is 2,810 ft. above sea level.

Ore, flux, and fettling material are unloaded into one of six reinforced-concrete receiving bins, of the hopper-bottom, self-cleaning type, each with a capacity of 3,800 cu.ft. The trestle approach to and the tail track from the bins is of steel, with timber ties and runways. A steel-apron ore feeder, 42 in. wide, having fixed intermediate idlers supporting the chains, all self-contained on a structural-steel frame, serves each bin. All of the feeders are driven from a line shaft through worm-gear reduction by a direct-current variable-speed motor, controlled from the gyratory-crusher platform. Provision is made for disengaging each feeder by means of a friction-clutch pulley; also for stopping the motor at the receiving bins. The feeders discharge into a movable-track hopper, which guides the ore into a 36-in. belt conveyor (No. 1) supplying the gyratory crusher. The bins were designed for material weighing 125 lb.



General plan of smelter, showing railroad connections to various departments



Crushing plant, sample mill, bedding bins, and conveyors

per cubic foot. Track stringers over the bins and trestle are figured for Cooper's E-40 loading. Four additional bins may be added in the future, to the north.

Materials unloaded into receiving bins or custom-concentrates bin are weighed on a 125-ton live-rail track scale adjoining the bins on the south, constructed with the usual dead platform of timber, and completely inclosed and supported by reinforced concrete. The track is about 28 ft. above the ground line at this point. A 15-ton locomotive crane is available for unloading.

Crushing Plant, Sample Mill, and Concentrates Bin

The crushing-plant and sample-mill flow sheet is shown herewith. Ore of about 12-in. lumps, maximum size, is delivered to a No. 7½ gyratory crusher, which makes a 2½-in. product. A 30-in. belt conveyor (No. 2), driven from the crusher pinion shaft, with magnetic head pulley, delivers the ore to 54x20-in. roughing rolls (page 690) where, by single pass, it is further reduced to ¾ or 1 in., then carried by a 30-in. conveyor (No. 3) to the sample mill. The discharge from conveyor No. 3 passes over an 8-ft. Hum-mer screen, the oversize returning on a 30-in. conveyor (No. 4) to 54x20-in. finishing rolls, set to about ¼ in., the product falling on conveyor No. 3. Provision is made so that the discharge from this conveyor may pass direct to the first Vezin samplers, which, of course, may also receive the screen undersize. The subsequent procedure in the sample mill is indicated in the flow sheet. The final sample is handled by the company's assayer.

Each 54-in. roll is driven by a 150-hp., 290-r.p.m., slip-ring motor, with extended rotor shaft on which are mounted the driver pulleys. The rolls operate at 112 r.p.m. A 75-hp. motor, with short-center idler, drives the gyratory crusher. Conveyors No. 1, 3, and 4 are each driven by a 10-hp. motor, with short-center attachment; the sample-mill equipment, except the screen, is operated by a 30-hp. motor. All motors have automatic, remote control. Excepting the sample-mill and conveyor No. 3 motors, controlled from the sample mill, all push-button stations are mounted on a panel on the gyratory-crusher operating platform. An electrical interlock prevents the crushing plant operator from starting conveyor No. 1 until No. 3 is in operation.

The rated capacity of the crushing plant is from 50 to 60 tons per hour. Within a wide range, the rate at which ore is delivered to the gyratory is controlled from the operating platform by varying the speed of the motor driving the feeders at the receiving bins. A 15-ton hand-power crane serves the 54-in. rolls and gyratory crusher. Crushed ore and sampler rejects are collected on a 24-in. belt conveyor (No. 5) running to the bedding bins.

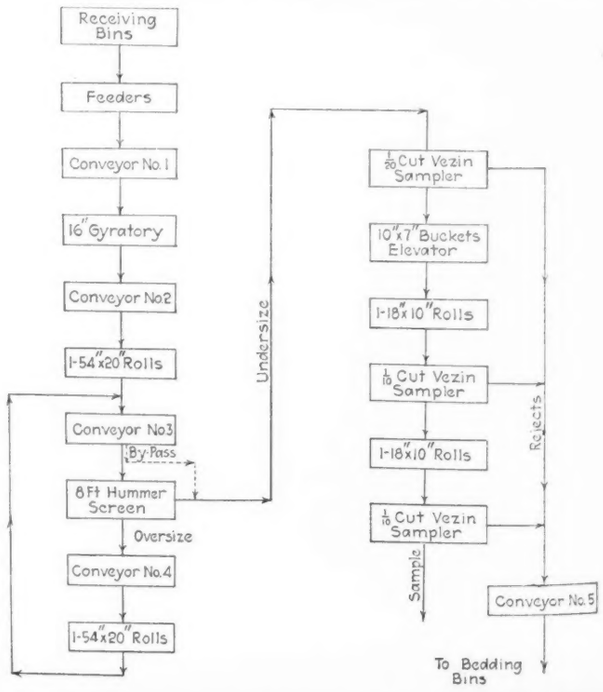
Particular care was exercised in detailing chutes and boxes in the sample mill, to avoid dead pockets or ledges, and so insure that samples would be representative.

The gyratory crusher, 54x20-in. rolls, and 18x10-in. rolls were furnished by the Traylor Engineering & Manufacturing Co.

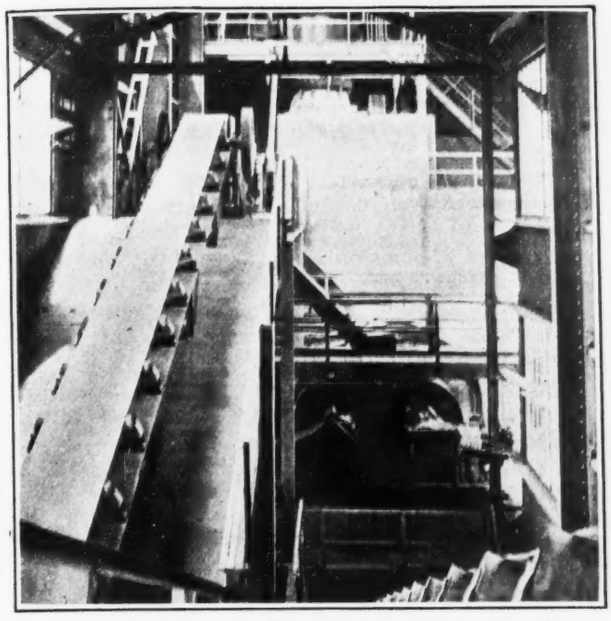
An extension of the track on trestles, over the receiving bins, serves the custom-concentrates bin, also of reinforced concrete and with a capacity of 6,490 cu.ft. The bottom is V-shaped and has a slot or opening 2 ft. wide extending its full length. On each side of the opening a ledge is provided for receiving a 4x6-in. plank, 2 ft. 8 in. long, which spans the opening. In one end wall is a 2 ft. 8 in. by 6 ft. high-louvred opening. The bottom opening and plank are carried about 3 ft. past this end wall. Here, also, a suitable platform is constructed for starting the concentrate in the descent to the 24-in. belt conveyor (No. 10) running immediately below the slotted opening. As the concentrate is raked down, the planks are removed consecutively, so that the labor in handling is minimized and feeding is regular. The conveyor has skirt boards extending the length of the bin, between which, at intervals, diaphragms are placed to arrest and control the load the conveyor may carry. Conveyor No. 10 terminates in the junction house and discharges on conveyor No. 5. Concentrate is sampled in the car, for moisture and assay, by the customary pipe or auger method.

Pumping of Concentrate to Smelter Is Novel Feature

As stated previously, the concentrating mill is about 4,000 ft., by rail, from the smelter; the problem of transporting concentrate therefore involved considerable attention and study. Transportation in cars necessitated special equipment; loading, unloading, and hauling to smelter would be an expensive series of operations. It was finally decided to erect the filters at the smelter and pump the concentrate thither during one eight-hour



Flow sheet of crushing plant and sampling mill



Conveyor No. 4, taking screen oversize to rolls

shift per day. The filters are about 100 ft. lower than the tanks in which the concentrate is stored at the mill.

Two pipe lines were surveyed between mill and smelter. The one, a gravity line, was 3,700 ft.; the other, about 2,700 ft., necessitated the elevation of the concentrate an additional 100 ft. over an intervening ridge, after which there was a drop of 200 ft. to the filter plant. The latter route was adopted, as it was thought that the tendency for solids to settle and choke the line would be less pronounced; also, the loss of metal in the pipe, due to abrasion, an important factor, is directly proportional to the length. Then, too, the initial lift of 100 ft. is partly compensated by the siphon effect produced. An air line is tapped into the 4-in. pulp line at its highest point, where compressed air is introduced after each run, to clean the pipe.

Table and flotation concentrates, in about equal proportion, are pumped by means of Wilfley pumps through a 4-in. pipe line and received in three 12x10-ft. elevated agitating tanks, of the Goldfield type, outside the filter building. The pulp density of the material pumped is about 65 per cent solids. The present filter equipment consists of one 12x12-ft. and two 12x6-ft. Oliver filters, with the necessary vacuum pumps, receivers, and moisture traps. There is space for an additional 12x12-ft. filter. A water leg was used in place of a centrifugal pump, terminating in the first of three settling tanks, in series, where any entrained concentrate is collected.

Pulp flow from the Goldfield tank is regulated by standard 4-in. gate valves and laundered to the filters through a distributing box. The entire floor, of concrete, drains to a sump, from which any overflow is pumped back to the agitating tanks. The cake from the filters falls onto a 24-in. belt conveyor (No. 11), which discharges onto conveyor No. 5 through a hopper in common with conveyor No. 10. Conveyor No. 11 is equipped with an automatic weigher. It is intended to transport materials on conveyors Nos. 10 and 11 when conveyor No. 5 is receiving crushed ore, thereby bedding the latter with dry material and avoiding adherence of the concentrate to the belts. Each conveyor carrying concentrate has an adjustable belt scraper on the head pulley, which cleans the belts effectively. Concentrate has at times been handled alone, without much sticking.

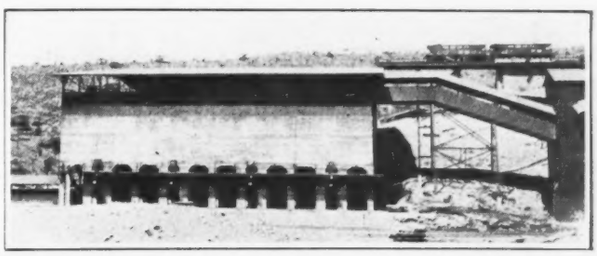
Conveyor systems are equipped with adequate control devices. Four bedding bins extend at right angles to conveyor No. 5, each with a capacity of 32,000 cu.ft. These bins are of reinforced concrete, with steel superstructures. The method of handling material is identical to that practiced with the custom-concentrate bin. The end of each bin immediately below conveyor No. 5 is partitioned to provide a separate pocket of about 3,750 cu.ft. capacity for the storage of silica, limerock, and direct-smelting ores that require no roasting. Silica for the converters and ore for the reverberatory are drawn by belt feeder onto the conveyor going to the roasters, or into cars, by arc gates and chutes.

Conveyor No. 5 is equipped with a tripper, which may be set to discharge onto any one of the four 24-in. belt conveyors (No. 6), over the bedding bins, or into the storage pockets. The usual chute on the tripper is replaced by a cross-belt, to avoid the aggregation of sticky material in the chute. The tripper travel and cross belt are actuated by conveyor-belt mechanism.

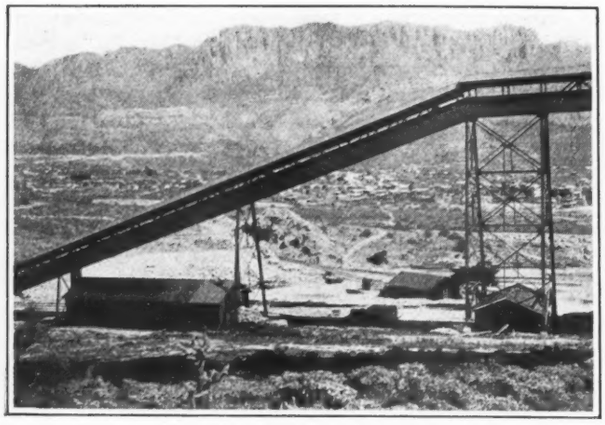
A tripper on each No. 6 conveyor, which distributes the charge in the bedding bin, is of special design and driven by two direct-current, 5-hp. motors, to propel it, and a 3-hp. motor to drive the cross-belt. Direct-current rather than alternating-current motors were chosen for this service because the control equipment is simpler. The tripper travels at 20 ft. per minute, being automatically reversed at the end of the bin. Should the reversing mechanism fail, a track-limit switch breaks the circuit and stops the motor. The cross-belt operates at 300 ft. per minute, discharging in one direction while the tripper makes a complete cycle. It travels up and down the length of the bin and is then reversed automatically. The mixed charge is collected on four 24-in. belt conveyors (No. 7), as described in connection with the custom-concentrate bin. These discharge on a 24-in. horizontal belt conveyor (No. 8), which, in turn, delivers to a 24-in. inclined conveyor (No. 9) to the roaster plant. The trippers were manufactured by the Meese & Gottfried Co.

Conveyor No. 5 is driven by a 20-hp. motor, direct-connected through gearing. Conveyors Nos. 6, 7, and 8 have each a 5-hp. motor drive with short-center attachment. The 24-in. belt feeders under the pockets are driven by a 3-hp. motor, each feeder having a tight-and-loose pulley.

An electrical interlock has been arranged so that the stopping of a motor actuating any tripper or conveyor No. 6 will automatically trip out, consecutively, all the conveyor motors back to and including conveyor No. 1, as well as the motor driving the feeders under the receiving bins. This feature has been applied to each conveyor, so that stoppage of the motor, by reason of failure of current, trips all preceding conveyor motors. Moreover, by this arrangement it is impossible to start a conveyor unless the conveyor to which it feeds is in operation. Any conveyor may be tested out or operated



Four bedding bins, each of 32,000 cu.ft. capacity

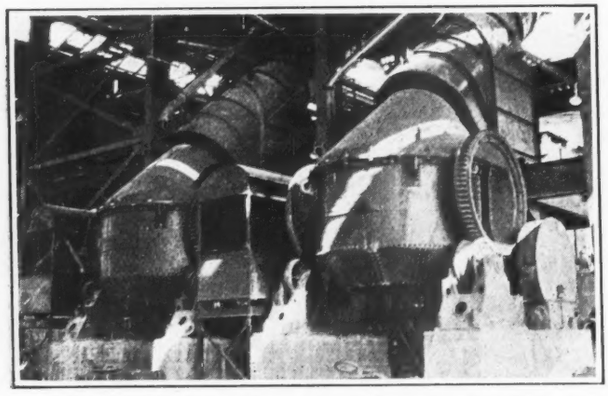


The conveyor to roasters is horizontal for 55 ft.

independently if the starting button is held down; when this is released the motor is tripped. These same interlocking features are applied to conveyors Nos. 9, 8, and 7, and to the belt feeder under the storage pockets at the bedding bins.

Five eight-hearth (exclusive of drier hearth) 19 ft. 6 in. diameter Herreshoff roasters are installed, with space left for an additional unit in the present building. Conveyor No. 9 delivers material and distributes to the roaster-charge hoppers by a tripper provided with a cross belt. The tripper is propelled and the cross belt is actuated by the conveyor belt, motion being secured from the idler pulleys on the tripper. The cross belt is reversible by manual control. Conveyor No. 9 is horizontal for a distance of 55 ft. to the north of the building, to permit extensions to accommodate four additional roasters.

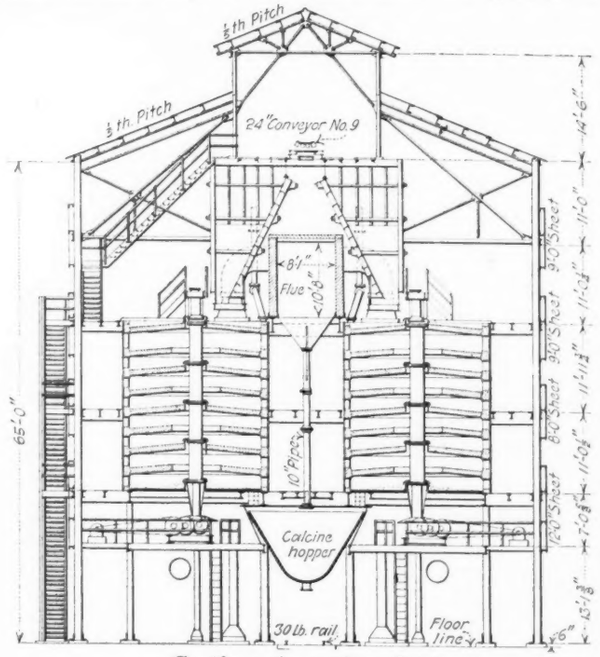
Each roaster-charge hopper has a capacity of 75 tons. The feeding device is of the standard Herreshoff type, with adjustable scrapers, which drag material from the bottom or shelf plate of the hopper at each revolution. The scrapers are adjustable in that they may be extended to reach into the charge, or more scrapers may be added. Thus the rate of feed is very flexible. The bottom area of the charge hoppers was designed considerably in excess of usual practice, to avoid arching or clogging of the feed. The upper roaster shaft support (top frame) was raised about 5 ft. above the drier hearth, to avoid danger to an operator who might otherwise be caught between the rabble arm and this support. An auxiliary pocket of eight tons' capacity is provided in the upper end of each charge hopper for lime rock, which is spouted through an 8-in. standard pipe to an automatic feeder on the second hearth from the bottom, where it may be introduced and intimately mixed with the calcines. The fingers on the rabble arms scrape the lime rock, the quantity being controlled by a vertical, adjustable slide gate that regulates the depth of the pile through which the fingers sweep.



Two Great Falls type converters are provided

Each roaster uptake, of cast iron, with a butterfly damper to control the exit gases, terminates in a flue 10 ft. 8 in. high by 8 ft. 1 in. wide inside. The sides and top are of common brick, and the top consists of a series of jack arches 8 in. thick. The bottom is of steel plate hoppers, from which 10-in. diameter steel pipes, with slide gates, discharge the dust into the calcine hoppers.

One calcine hopper serves two roasters. The hoppers are insulated on all sides with 2½-in. Sil-O-Cel brick, protected by steel liner plates. There are two discharge gates on each hopper, the dimensions and spacing of

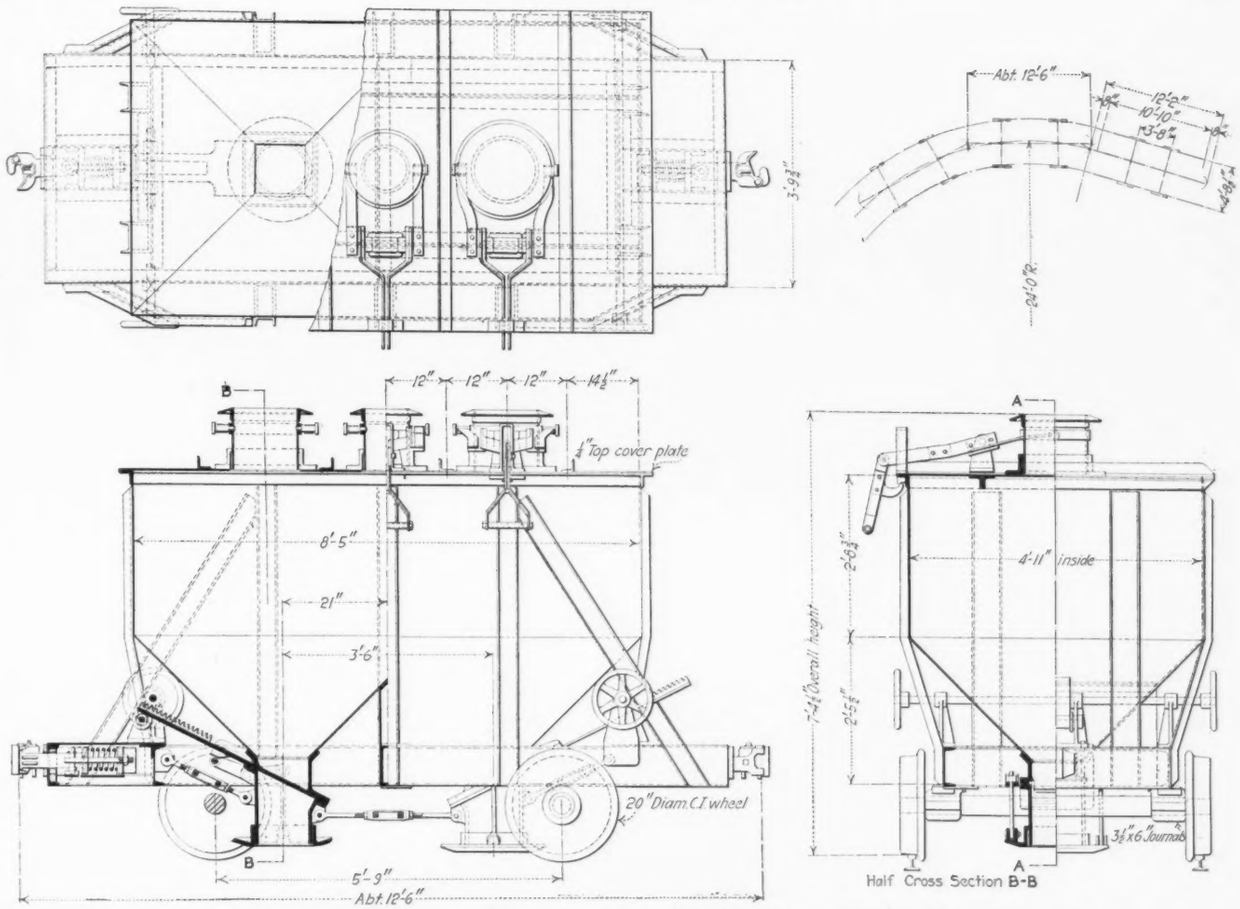


Section of roaster plant

which conform to the inlet hatches on the calcine car. A connection on the hopper admits air, from the calcine car, that has been displaced by calcines. Access to the hoppers is provided by hinged doors in the floor and top cover. Two 4-in. pipes with covers pass through the floor into each hopper for observation.

Three 5,000-cu.ft., direct-connected B. F. Sturtevant Co. fans, of the steel-plate type, furnish air at 3-in. static pressure, for cooling the shaft and rabble arms. The preheated air from the center shaft is returned through piping to the bottom hearth, where it is utilized to support combustion of the sulphur. The normal air requirement per furnace is 2,500 cu.ft. The fans discharge into a header, with branches supplying the roasters. Two oil burners, of local make, using steam as an atomizing agent, are provided for each roaster. It is only necessary to use extraneous fuel when starting the furnaces, the charge being self-roasting. The roasters are insulated inside the steel shell between the arch blocks with 4½ in. of Sil-O-Cel brick. Firebrick is used throughout the interior.

The roaster building is of steel, except the decking at the conveyor level, which is of timber. Floors are constructed of special ¼-in. plate. Stairways serving the



Design of calcine car. These are of steel plate with a capacity of 6 tons

floors were placed outside the building so that the floor space around the furnace might be unobstructed; there is only one intermediate floor for access to the furnace-hearth doors. Each furnace is driven by a 7½-hp. motor. Conveyor No. 9 has a 25-hp. motor, direct-connected through reduction gears. The charge hoppers are filled and all crushing, conveying, and bedding is done in one eight-hour shift per day.

The Cottrell plant, of sufficient capacity to treat the roaster gases only, comprises four distinct units, each containing 144 boiler tubes, 8-in. in diameter and 12 ft. long, as receiving electrodes. These are suspended from overlapping cast-iron floor plates, supported by structural-steel beams, and anchored near the lower end in the usual manner. The discharge electrodes, of No. 3 Triumph chain, are hung central in each tube from a pipe grid overhead. The rapping mechanism vibrates both the discharge and receiving electrodes in one operation, the receiving electrodes being vibrated by the hammers striking the rapping plates. A separate swinging hammer strikes a glancing blow on a screen mounted on the discharge-electrode lower grid, to vibrate the discharge chains.

The inlet flue enters the building at the top, at about the same elevation as the flue in the roaster plant. The gases are conducted from this through steel boxes, which house the inlet dampers, of the hatch-door type. The bottoms of the flues and boxes are sloped, to prevent an accumulation of dust. Separate hand winches are provided for raising and lowering the inlet and outlet dampers of each unit, the outlet dampers being also inclosed in a steel box. The control mechanism for all equipment is accessible from one platform.

Hoppers of large capacity are provided for collecting the precipitated dust, each being equipped with two discharge gates, which register with the hatches in the calcine car. High-tension lines are fully protected with screens to insure safety to operators.

The reverberatory furnace is 22x94 ft. inside measurement, with side walls 22 in. thick at the top and 27 in. at the bottom. The arch is 20 in. thick, has a rise of 1¼ in. per foot, and is horizontal for the full length of the furnace. Silica brick was used throughout, except at the throat, where a wall of firebrick and common brick was placed outside the inner wall of silica brick. Side buckstays are made up of two 12-in. 31½-lb. I-beams, spaced at 3 ft. 6 in. centers, and secured at the bottom by tapered-steel plate wedges, ¾ in. thick at the top, bearing against rails embedded in the concrete. The concrete thrust blocks along the side of the furnace are 8 ft. wide by 3 ft. 6 in. deep. The concrete blocks across the front and rear are heavily reinforced and anchored back in the side blocks. The throat area is 60 sq.ft.

Calcines are introduced into each of the charge hoppers through suitable hatches, spaced to conform to the calcine-car outlet gates, and closed by a slide gate actuated by a lever, which is readily accessible to the operator. In each hatch is placed a grid made up of round bars, to arrest tramp iron or other material that might interfere with the operation of the gates. Standard 8-in. pipes, spaced 3 ft. 6 in. centers, conduct the calcines into the furnace. The flow is controlled by inclosed, basket-type arc gates, secured to the charge hoppers and operated from the elevated runway. The lower end of the pipe terminates in a special casting,

inserted into the furnace arch, and provided with a peephole for the convenience of the operator. Calcines are weighed on a 30-ton, live-rail track scale under the Cottrell-plant building. Although three taps are provided on each side of the furnace for emergency, the matte is normally tapped about 36 ft. from the rear wall and laundered to the converter aisle. The launder has a slope of ½ in. per foot.

The reverberatory furnace is equipped with six oil burners of the Billow type, utilizing air for atomizing at 32 oz. pressure. Primary air for burners was figured on a basis of 42½ cu.ft of free air per pound of oil per minute. A direct-connected General Electric centrifugal compressor, with a capacity of 3,500 cu.ft. per minute, supplies the atomizing air, a second being held in reserve. Oil is delivered to burners preheated and at a pressure of 125 lb. (gage) by a 6x4x6-in. reciprocating, duplex pump. The power end operates on saturated steam at 200-lb. pressure. The oil is first heated by the exhaust steam from the pump, and then passes through a second heater, where live steam is introduced. Three oil-gaging tanks outside the building, each of 210 bbl. capacity, ample for an eight-hour run, are equipped with heater coils and provided with gage boards carefully calibrated and graduated to read in barrels.

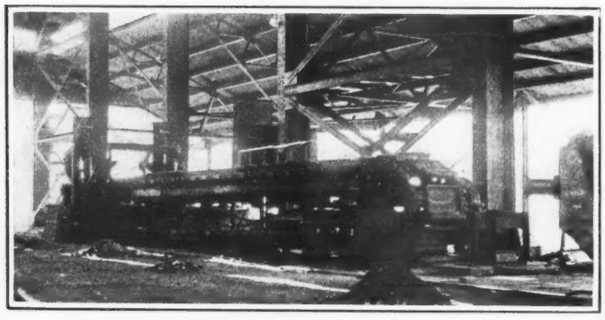
Furnace gases pass through the uptake, then turn normal to the long axis of the furnace into two Erie City vertical boilers of 697 rated horsepower each. These are arranged for "double pass," and are elevated so that the center of the bottom drum is at the same height as the top of the crossover flue arch. The gases from the furnace impinge on a bridge wall, the top of which is carried up to the center line of the drum. The boilers are provided with soot blowers and superheater elements, and are arranged for independent firing. The exit gases are controlled by canoe-type dampers, actuated by hand wheel through worm gearing. An indicator shows the position of the damper. The minimum area of boiler inlet flue is 45 sq.ft. and the exit-gas openings have an area of about 36 sq.ft. Either boiler may be cut out by inserting a damper in the inlet flue. Steam is generated at 200-lb. gage pressure and 100 deg. superheat.

Slag is skimmed at the front end of the furnace into one of two 225-cu.ft. M. H. Treadwell Co. slag cars tilted by a 20-hp. direct-current motor, the control for which is in the cab of the trolley locomotive.

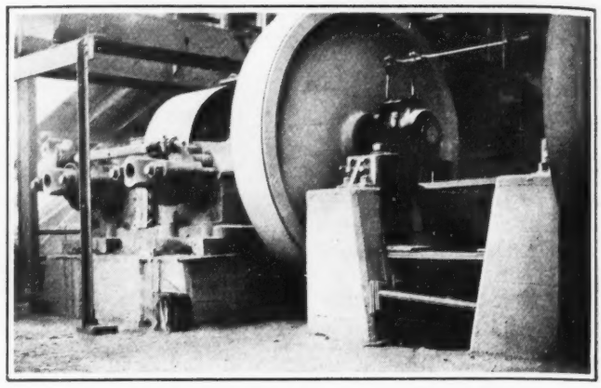
The concrete floor over the slag tracks is protected by steel plates sprung between the steel floor beams. A course of insulating brick is placed on the plate.

The converter aisle contains two 12-ft. Allis-Chalmers converters, a straight-line copper casting machine, and a special skull breaker.

Silica is loaded into special cars from the storage pockets at the bedding bins and dumped into an elevator



A straight-line casting machine is used



Ore is crushed to 1 in. in 54x20-in. rolls

boot, which discharges into an elevated storage hopper over the converters and placed centrally between them. The 24-in. belt feeders, direct-connected to 3-hp. motors through speed transformers, convey the silica to the suspended hopper scales, of 6,000 lb. capacity. The discharge gates on the scale hoppers are operated by an electric solenoid. The solenoid push button, and the push-button starting stations for motors, are controlled from the operator's platform on the converter floor. Here, too, are the beams from the hopper scales.

The copper-casting machine is set lengthwise to and on one side of the aisle adjoining the casting shed. Copper pigs are handled by warehouse trucks and weighed on one of two depressed platform scales, each of 5,000-lb. capacity. The loading track is also depressed, to facilitate loading copper into cars. The ladle-tilting mechanism is driven by a 30-hp. slip-ring motor; a 25-hp. motor drives the mold line.

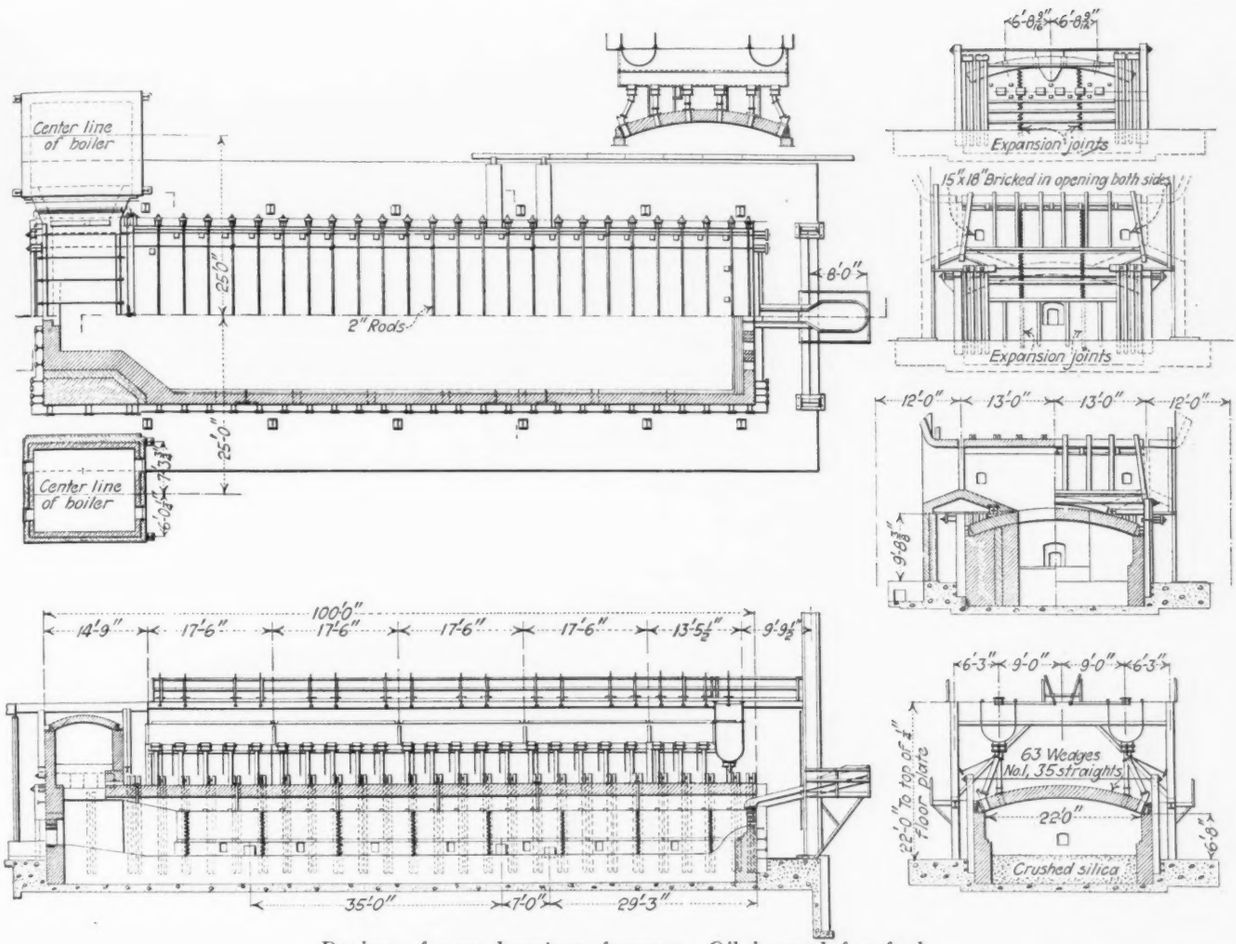
The ladles used for handling matte, converter slag, and copper are of similar design, of steel, and each with a capacity of 90 cu.ft. They were furnished by the Allis-Chalmers Manufacturing Co. Two 40-ton, four-motor Shaw electric cranes serve the converter aisle. The auxiliary hoist has a capacity of twelve tons.

The skull breaker is in the southeast corner, built of structural steel shapes at a sufficient height above the main floor to accommodate a standard-gage gondola car. The grizzly section is about 10x18 ft. in plan, made up of heavy I-beams, protected on the upper flange by flat steel wearing bars. The cross bars are strengthened by 70-lb. rails, placed on top. The openings are 9x18½ in. Skulls are broken through the grizzly by a flat circular drop hammer weighing about 1,200 lb. and raised with the electric-crane hoist. The scrap boats are 6 ft. wide, 8 ft. long, and 12 in. deep. The silica boats are 10 ft. long, 20 in. wide, and 21 in. deep.

Distilled Water Is Fed to Boilers

The power-plant building occupies a floor space of 54x128 ft. and contains a basement under the entire area. On the engine-room floor are two 1,500-kw. Westinghouse geared turbo-generators, one 12,000-cu.ft. Nordberg steam-driven blowing engine, two 150-kw. motor-generator sets, and a 13-panel switchboard. Each turbine is provided with a 3,000-sq.ft. Westinghouse surface condenser, integral with a unit-type circulating and condensate pump driven by geared turbine. Vacuum is maintained by duplicate steam-jet air ejectors. The blowing engine has an 800-sq.ft. surface condenser with motor-driven circulating and condensate pumps and steam-jet air ejectors.

The impurity of the available water necessitated the installation of a double-effect evaporator plant, to supply



Design of reverberatory furnace. Oil is used for fuel

distilled water for boiler feed. The evaporators, circulating pumps, closed heater, distiller, boiler-feed pumps, filter, and transformers are placed in the basement, together with the centrifugal compressors for supplying primary air to the oil burners at the reverberatory. The open heater is placed on the engine-room floor, with the condensate or surge tank elevated above the heater, where space has also been provided for the compressors to supply air for the mine and smelter. One boiler-feed pump is operated by steam, the other being motor driven.

Current is generated at 2,200 volts. The 54-in. rolls and gyratory-crusher motors and the two 150-kw. motor-generator sets operate on the 2,200-volt circuit; all other alternating-current motors are on a 440-volt, 3-phase, 25-cycle circuit. Lighting circuits are at 110 volt, 25 cycle. A 10-ton hand-power crane is available for the power-plant equipment. Advantage was taken of a natural gulch to the west of the reverberatory building for providing storage for condenser circulating water and space for the spray system. A gravity-section concrete dam impounds the water.

The Cottrell power plant is contained in an adjoining room on the northwest corner of the power-plant building. The floor is at the same level as the engine-room floor, for convenience of the operator in charge of both plants. The following equipment is installed: Three 25-kva. motor-generator sets, three 75,000-volt rectifiers, three 75,000-volt transformers, two 4-kw. exciter sets, and the switchboard. The rectifiers were furnished by the Kelman Electric & Manufacturing Co.; all other equipment was furnished by the General Electric Co.

Four high-tension lines run through the Cottrell power plant to the Cottrell treaters, one for each unit. Disconnecting switches are provided so that any line may be connected to either rectifier bus. Resistors, of special design, are placed on each connecting line, one at the exit from the power plant and one at the inlet to the Cottrell plant. The function of these is to dampen the high-frequency oscillation, so that no interference may be offered to radio apparatus.

Each calcine car has a capacity of about six tons, the body and frame being of steel plate and structural-steel shapes. Inlet hatches are of 12½-in. diameter, spaced at 4-ft. centers, made of an annular sleeve sliding in a casting secured to the top cover of the car. The sleeve is forced against a corresponding casting on the calcine hopper by a spring lever, a similar mechanism regulating the air vent between car and hopper. The discharge gates consist of a flat-steel plate actuated by a hand wheel through rack and pinion. This motion also lowers a sliding sleeve to engage the flanged hatch opening on the reverberatory-charge hoppers. The outlets are annular castings, 10 in. diameter spaced at 3 ft. 6 in. centers. Cars of similar design but open at the top are used for transporting silica and flue dust.

Construction Details of Stacks and Flues

Fuel oil is stored in a 20,000-bbl. tank. A rotary positive-displacement pump at the storage tank, of 70 gal. per minute capacity, distributes oil to the reverberatory gaging tanks and to an elevated tank for supplying locomotives. Oil cars are "spotted" on the spur near the engine house, and may be unloaded by

gravity; however, piping and valves are arranged so that the rotary-pump suction may be used to accelerate the flow through the pipe and to force the oil into the tank under pressure.

The stack is 300 ft. high above the concrete foundation, 20 ft. inside diameter at the top, and 29 ft. 1 in. inside diameter at the bottom, with a wall at the bottom 39 in. thick and at the top 12½ in. It is constructed of common brick made locally by the company. The stack was designed for a horizontal wind pressure of 25 lb. per square foot of projected area with no tension in the brickwork, Maximum compressive stress was limited to 200 lb. per square inch. Brick used weigh 110 lb. per cubic foot and in dimension are normally 8x4x2¼ in. The ultimate crushing strength is 2,000 lb. per square inch or over. The inlet flue opening is 12 ft. wide by 30 ft. high, and the stack is lined for a height of 75 ft. above the base. A testing platform, 4 ft. wide, and extending 90 deg. around the stack, is provided 75 ft. above the base. The top is capped by overlapping terra-cotta tile. Nine copper lightning rods, ¾ in. diameter, platinum tipped, extend 8 ft. above the top, and connect with three cables to the ground. The top of the concrete foundation is at an elevation of 2,832 ft. The stack was erected by the Alphons Custodis Chimney Construction Co.

The flue system was designated to provide the shortest run possible. The main or reverberatory flue, in front of the boiler house, has an area of 240 sq.ft. with the floor sloped 6 in. to 1 ft. toward the building, and paved with one course of common brick set on edge. The roof is composed of a series of 8-in. jack arches having a rise of 1 in. per foot and supported by I-beams, the lower flanges of which are protected by wire netting and cement mortar. This part of the flue is cleaned out into cars on the slag track. The outlet flue of the Cottrell plant has an area of 128 sq.ft. and is supported on structural steel across the calcine and flue-dust tracks. The converter flue is 9 ft. in diameter and of the balloon type, supported on steel bents, which also carry the track for transporting silica to the converters and cleaning out the flues. For this purpose, dust gates are provided at frequent intervals. The balloon flue terminates in the reverberatory flue. A butterfly damper at this point controls the draft and permits disconnecting the balloon from the reverberatory flue. The side walls of the brick flues are 13 in. thick, except on the approach to the stack, where they are 17 in. thick on the lower part.

Shops Equipped With Wide Variety of Machines

A 13-ton trolley locomotive is used for slag haulage and a four-ton battery locomotive for transporting calcine, silica, and other material. The machine, forge, and plate shops are housed in one building. The main bay is 128 ft. long by 38 ft. wide, with a 10-ton, hand-power crane overhead; the side bay is 24 ft. wide. All of the larger tools in the main bay are provided with independent electric drives, the smaller tools being belted and driven by a 15-hp. motor. The following equipment has been provided:

Double-end No. 3 punch and shear; 6-ft. bending rolls; 8-ft. hydraulic flanging clamp; 5-ft. radial drill; 30-in. x 8-ft. planer; 36-in. x 12-ft. engine lathe; 16-in. x 8-ft. lathe; 24-in. shaper; 1½-in. bolt cutter; 8-in. hacksaw; ¼-in. to 2-in. pipe machine; 2-in. to 8-in. pipe machine; wet and dry grinder; 1,100-lb. steam hammer; 3½-ft. wall-type radial drill; No. 3 Buffalo blower.

The warehouse occupies a floor space of 45x60 ft. and is one story high, with the floor elevated 4 ft. above the receiving track on the east. It is equipped with an office for the attendant, a depressed-platform scale of 2,500 lb. capacity, and the usual shelving.

The general office is 38x30 ft., divided into four offices, with one vault 10 ft. 6 in. by 14 ft., having a screen partition. The assay office measures 47x55 ft. and is a one-story building. Separate rooms are provided for the chemical laboratory, metallurgical laboratory, balance room, furnace room, store room, and office. The grinding equipment is placed in a separate building 22x29 ft., in which are mounted a jaw crusher, a coffee mill, three disk pulverizers, a drug mill, three bucking boards, and a drying cabinet. The engine house has two stalls and is 40 ft. wide by 69 ft. 4 in. long, with engine pits and pneumatic jack for removing engine drivers.

In addition to the 125-ton track scale at the receiving bins, a 100-ton dead-and-live rail track-scale is located at Superior Station, for weighing incoming and outgoing materials, thus avoiding the haul to the scales at the receiving bins.

Asbestos-protected metal, 22-gage, was used for the roofs of the roaster building, Cottrell plant, reverberatory and converter building, power plant, and engine house. Copper-bearing corrugated sheets were used on the roofs of all other buildings and conveyor housings. The machine shop, warehouse, power plant, Cottrell power plant, general office, and assay office have brick walls for side closure. All other structures have 22-gage painted corrugated steel. Steel-sash windows with 14x20-in. lights are used in the crushing plant and sample mill, filter plant, junction house, Cottrell plant, power house, machine shop, and warehouse. The assay and general offices have wooden sash windows. Other structures have continuous openings in the corrugated steel siding.

The following quantities of material were used in the construction of the plant, for which 35,560 cu.yd. of excavation was necessary: Concrete, 7,320 cu.yd.; structural steel, 2,896 tons; reinforcing steel, 260 tons; corrugated steel, 120 tons; common brick, 2,225,000.

It may be of interest to present, in condensed form, the approximate theoretical calculations on gas volumes and heat balance, for roasters, reverberatory, and converters, which were used in the estimates of size of stack, flues, and other essentials. These calculations do not take into consideration secondary constituents, but are given as a general guide in the design of a smelting plant:

Volume of Roaster Gases

Capacity of each roaster, 75 tons per day; sulphur in charge, 30 per cent; sulphur in calcine, 10 per cent. Therefore, about 30,000 lb. sulphur is eliminated per twenty-four hours. Assuming the exit gases to contain 5 per cent sulphur dioxide.

Volume of sulphur dioxide formed from 1 lb. sulphur is $\frac{2 \times 16}{2.88}$ or 11.11 cu.ft.

Volume of air per pound of sulphur is $\frac{11.11 \times 95}{5}$, or 211 cu.ft.

Volume of gas per minute per roaster is $222 \times \frac{550 + 459}{491} \times \frac{30{,}000}{24 \times 60}$, or 9,510 cu.ft.

Weight of Roaster Gases

Weight of 11.11 cu.ft. of sulphur dioxide at 0.1786 lb. per cu.ft. is 1.98 lb. Weight of 211 cu.ft. of air at 0.0807 lb. per cu.ft. is 17.03 lb. Therefore, weight of roaster gases is $\frac{19.01 \times 30{,}000}{24 \times 60}$ or 396 lb. per minute, exclusive of entrained dust.

Volume of Reverberatory-furnace Gases

Assuming a furnace charge of 400 tons per day, made up of 338 tons of calcine, 15 tons of flue dust, and 47 tons of fettling ore and byproducts, sulphur remaining in charge, about 40 tons; 6.6 tons of sulphur available to form sulphur dioxide. Neglecting reactions of secondary constituents:

Air requirements for oil on basis of 0.75 bbl. per ton of charge equals $\frac{0.75 \times 400 \times 42 \times 8}{24 \times 60}$, or 70 lb. oil per minute.

Gas produced is $70 \times 20 \times 12.4$, or 17,360 cu.ft. per minute.

Gas produced by sulphur is $\frac{6.6 \times 2,000 \times 222}{24 \times 60}$, or 2,040 cu.ft. per minute.

Total volume of furnace gas at 2,100 deg. F. is

$$\frac{19,400 \times 2,100 + 459}{491}, \text{ or } 101,000 \text{ cu.ft. per minute.}$$

Weight of Reverberatory-furnace Gases

Weight of furnace gases equals $2,040 \times 0.0857 + 70 \times 20 + 70$, or 1,645 lb. per minute.

Heat in Reverberatory-furnace Gases

Heat in furnace gases, at 2,100 deg. F. is $1,645 \times 0.24 \times 2,100$, or 830,000 B.t.u. per minute.

Heat Absorbed by Matte

On a basis of 40 tons of copper produced per twenty-four hours, a 35 per cent matte would contain 40.9 tons of iron and 33.4 tons of sulphur, or a total of 114.3 tons of matte per day. Taking the temperature of matte at 2,400 deg. F., and the specific heat at 0.14:

Heat in matte is $\frac{228,600 \times 0.14 \times 2,400}{24 \times 60}$, or 53,400 B.t.u per minute.

Assuming 95 tons of matte constituents introduced into the furnace at 800 deg. F., and the specific heat at 0.15, then:

Heat in this material entering furnace is $\frac{190,000 \times 0.15 \times 800}{24 \times 60}$

or 15,800 B.t.u. per minute.

Therefore, heat absorbed by matte is equal to 53,400 —15,800, or 57,600 B.t.u. per minute.

Heat Absorbed by Slag

Assuming an analysis of slag as follows: SiO_2, 40 per cent; FeO (and any oxide of manganese present), 35 per cent; CaO, 10 per cent; Al_2O_3, 8 per cent, therefore,

Amount of slag produced per twenty-four hours is 400 — 114.3 — 6.6 — 5.1 (flue dust), or 274 tons.

Taking the temperature at 2,400 deg. F., and specific heat at 0.261, total heat in slag is $\frac{274 \times 2,000 \times 0.261 \times 2,400}{24 \times 60}$, or 238,000 B.t.u. per minute.

With calcine introduced at 800 deg. F., and assuming that 243 tons goes into slag, then:

Heat in slag from calcine is $\frac{243 \times 2,000 \times 0.15 \times 800}{24 \times 60}$, or 40,500 B.t.u. per minute.

Heat Generated in Reverberatory Furnace

By combustion of oil, $70 \times 18,000 = 1,260,000$ B.t.u. per minute.

By combustion of sulphur, $9.17 \times 4,000 = 36,680$ B.t.u. per minute.

Assuming that the heats of formation and decomposition of other constituents are balanced, the total heat generated is 1,296,680 B.t.u. per minute.

Summary of Heat Production, Absorption, and Losses Debit

	B.t.u. per Minute	
Credit:		
Calorific value of fuel oil	1,260,000	
Calorific value of sulphur	36,680	
		1,296,680
Debit:		
Heat absorbed by slag	197,500	
Heat absorbed by matte	37,600	
Heat in gases	830,000	
Loss by radiation, difference	231,580	
		1,296,680

Stack Computations

The stack was designed on the basis of the following data:

	Exit Gas—Vol. Cu.Ft.	Exit Gas—Temp. F.	Length of Flue, Ft.	Base of Stack—Temp. F.	Base of Stack—Vol. Cu.Ft.
10 roasters at 15,000	150,000	550	325	350	120,000
2 reverberatories at 125,000	250,000	1,900	255	375	89,000
2 converters at 50,000	100,000	700	475	350	70,000

This gives about 279,000 cu.ft. gas at 355 deg. F. at the base of the stack. At 2,800 ft. elevation, with the barometer at 27, and the temperature of the outside air at 120 deg. F.:

Weight of outside air is $\frac{1.3255 \times 27}{459.2 + 120}$, or 0.0618 lb. per cu.ft.

Weight of inside gas is $\frac{1.3255 \times 27}{459.2 + 355}$, or 0.0439 lb. per cu.ft.

Assuming the stack to be 300 ft. high, or 322 ft. above the reverberatory floor, then:

Difference in weight between inside and outside air column is 322 (0.0618 — 0.0439), or 5.76 lb.

Theoretical draft at the reverberatory furnace is $\frac{5.76}{5.1}$, or 1.11 in. water.

Draft Losses

The draft losses in inches of water are as follows: Through boilers, 0.25; three right-angle bends, 0.18; flue, 500 ft. long at 0.10 per 100 ft., 0.50; accelerating gases, 0.08. The minimum draft required at the base of the stack is therefore 1.01 in. water. The theoretical flow or velocity through the stack is about 62 ft. per second without considering the retardation due to friction, which is a variable quantity depending on such factors and density, velocity, volume, temperature, and the inside condition of the stack. It is safe to assume a velocity of 30 ft. per second. This would require an effective area of 154 sq.ft. Allowance must be made for additional plant expansion, the infiltration of air and reduction in temperature; consequently, this figure should be about double, or an effective area of about 308 sq.ft. should be provided. This requires a stack 20 ft. inside diameter at the top.

Results Obtained

Excavation on the benches was begun in January, 1923. Concentrates were distributed into the bedding bins Jan. 1, 1924, and actual smelting operation begun on March 1, 1924.

The smelter has been in operation only a short time at the date of writing (July 28, 1924), and accurate data on results are not available. In general, the plant apparently is functioning satisfactorily, after straightening out a few of the usual kinks and breaking in the operating crews. This is evidenced by an output of more than 2,000,000 lb. of copper during the first month, the anticipated production.

The crushing plant, sample mill, bedding, and conveyor system operated without any unusual starting difficulty. During the latter part of April the pumping of concentrates from the mill to the smelter was begun at the rate of 164 gal. per minute of pulp containing about 65 per cent solids by weight.

The roasters are operating satisfactorily, and from present indications the insulating brick used will prove highly efficient.

The reverberatory furnace, boilers, and converter plant began operations with little delay. It was found necessary to provide additional openings in the boiler setting to facilitate cleaning the front bank of tubes. The fuel-oil consumption in the reverberatory furnace is lower than was estimated. The power-plant heat balance has been approached very closely in the first few months of actual practice.

The complete smelting plant was designed by Bradley, Bruff & Labarthe, of San Francisco, in co-operation with the officials of the Magma Copper Co., A. J. McNab, vice-president, W. C. Browning, general manager, and E. G. Dentzer, construction engineer. Bradley, Bruff & Labarthe were represented, during construction of the plant, by A. D. Moir.

Bauxite Deposits in Greece

Bauxite deposits have been found in the region southeast of the mountains of Parnassos, Xirovouni, and Kirfis, district of Distomon, Attica and Beotia, in Greece. They are being exploited by the Barlos Greek Bauxite Mines Co.

The area begins on the north shore of the Bay of Corinth, 25 miles to the east of the town of Patras. There is a well-protected port called Aspra Spitia, where steamers can load. The greater part of this region belongs to the Jurassic and Cretaceous period.

Samples taken during the exploration, as well as samples from the mine under exploitation now, taken by the representative of the National Bank of Greece, and sent for analysis at the laboratory of L. Campredon in Saint-Nazaire, France, show the following contents of the ore:

Constituent	Per Cent	Constituent	Per Cent
Silica	2.20	Magnesia	Trace
Alumina	72.20	Titanic acid	2.40
Iron oxide	9.80	Sulphur	Trace
Lime	Trace	Loss on ignition	13.20

Marketing of Vanadium Ores and Metal*

South America Supplies Most of the Ore, But It Is Converted in the United States

By Frank L. Hess
U. S. Geological Survey

VANADIUM is the great toughener of steel. Whether its action is only to remove impurities, gaseous or solid, or whether it is to do this and also combine with the carbon or the iron, or both, nothing else makes steel bear torsional strains and bending so well, for only after treatment with vanadium can steel bars so readily be tied into knots. For use in mild steels usually 0.15 to 0.25 per cent of vanadium is added to the melt. Spring steels are said to be improved materially by the addition of similar small quantities. Nearly all high-speed steels are made with a vanadium content of 0.7 per cent to 1.3 per cent.

Other uses for vanadium are comparatively unimportant. A little has been used in medicines, inks, dyes, brass, bronze, bearing metals, and paint. It will be apparent that all but an insignificant part of the vanadium mined is intended for the production of ferrovanadium, in which form vanadium is introduced into steel.

Dr. Saklatwalla is fond of saying that the chemistry of vanadium is as complex as that of carbon, and, as would be suspected of an element with such a variety of affinities, it is found in mineral associations of very different characteristics.

The marketing—that is, the selling—of any material depends on the competition it must meet, and perhaps in no other mineral commodity is it more necessary to understand the competition, present and prospective, to be met from other deposits, than in vanadium; so I will describe briefly the various types of vanadium deposits. There is also competition to be met from nickel, chromium, and molybdenum.

Patronite Deposits, the Main Source of Vanadium

The largest source of vanadium has been and still is a unique deposit at Mina Ragra, Peru, where a sulphide mineral, patronite, carrying an excess of sulphur, was discovered with asphaltite and small quantities of sulphides, molybdenum, nickel and iron, all in a gangue of gypsum. Hewett[1] calls it "an extreme phase of differentiation from asphaltite." Nowhere else in the world has a single specimen of patronite been found. The patronite has now seemingly all been mined and the remaining ore is mostly an indistinguishable hodgepodge of minerals, among which are the hydrous calcium vanadates hewettite (red), pascoite (orange), fernandinite (dull green), and melanovanadite (black), and the blue hydrous sulphate, minasragrite. The deposit is inclosed in shale and some of the minerals replace the shale. For a number of years more than half of the world's vanadium came from this deposit, and during the last two years or more a still larger part. The richest ores have been mined, and whereas after roasting and preparing for shipment, they formerly carried about 26 per cent V (equivalent to 46 per cent V_2O_5), they now carry 8 to 13 per cent V (14 to 23 per cent V_2O_5), and the supply of this grade is by no means unlimited.

The deposit is at an altitude of about 16,000 ft., in a barren, desolate country, 28 miles from the railroad at Ricran, a point 230 miles from the coast at Callao.

The property was opened and developed by the American Vanadium Co., of Pittsburgh, but was bought in September, 1919, by the Vanadium Corporation of America, which now owns and operates the property and ships the ore to its own smelter at Bridgeville, near Pittsburgh. It has been the policy of both companies to mine large quantities of ore ahead of demand and store it at the Bridgeville plant, and shipments have not been uniform either in gross tonnage or in contained vanadium.

At first, smelting losses were very great, as much as 65 per cent, for this type of smelting was pioneer work and knowledge was acquired at considerable cost. The ore carried sulphur, nickel, and molybdenum, all of which had to be eliminated. A number of types of smelting were tried, and under Dr. B. D. Saklatwalla electric smelting has been brought to a high efficiency, so that recoveries are comparable to those in skillfully conducted operations in reducing other ores. The slags of former days are all being re-worked, and great quantities of vanadium have been recovered—more than a year's supply for the world. Dr. Saklatwalla has developed a tightly inclosed electric furnace with a closely controlled input of electricity which he says will enable him to smelt ores carrying as little as 1 per cent of vanadium. At present the company can supply the world's demand for vanadium from its own deposit and stocks, including slags.

Carnotite Deposits Furnish Domestic Ore

The second largest supply of vanadium has been that produced as a byproduct in the isolation of radium from the carnotite ores of Colorado and Utah. The deposits are in loosely cemented sandstones of McElmo age (upper Jurassic?). The radium-bearing mineral, carnotite, carries about 11 per cent V (20 per cent of V_2O_5) and the carnotite is accompanied by several other vanadium minerals, the principal of which is an imperfectly known mica-like mineral in exceedingly minute flakes a thousandth of an inch or less in diameter filling spaces between the sand grains of the rock. Besides the micaceous mineral, the ore carries hewettite and metahewettite (which have the same chemical compositions, but have different optical properties); uvanite (hydrous uranium vanadate), vanoxite (black hydrous vanadium oxide), and other vanadium minerals.

The ores almost invariably carry more vanadium than uranium, and around the carnotite deposit is an envelope of dark vanadium-bearing rock carrying as much as 9 per cent V (16 per cent V_2O_5), though usually much less; but most of the deposits are small, containing only

*Published by permission of the Director of the U. S. Geological Survey.

[1]Hewett, D. Foster: "Vanadium Deposits in Peru." *Trans.*, A.I.M.E., Vol. 40, 1910, pp. 274-299.

a few hundred tons or less of ore carrying from 1 per cent to 2 per cent V and a long way from the railroad—40 to 70 miles over poor roads—so that mining and delivery are expensive.

On account of their low grade and the cost of mining and delivery, the ores have paid only when worked in connection with radium. In the course of this process the vanadium was dissolved and finally obtained either as hydrous iron vanadate or as oxide and by most companies sold to ferrovanadium manufacturers. The product has a high degree of purity and was in good demand. The Standard Chemical Co., of Pittsburgh, and the Radium Company of Colorado, of Denver, made ferrovanadium from their own salts.

The discovery of very rich, easily mined uranium ores at Chinkolobwe, near Elisabethville, Katanga, in the Belgian Congo, has put most of the firms out of business, and the market for such ores has therefore almost disappeared.

However, the United States Radium Corporation, of New York, is still buying some rich uranium ores. The Standard Chemical Co. experimentally concentrated for their vanadium content the mined ores that it had on hand in Montrose County, Colo., 60 miles northwest of Placerville, but is understood to have stopped.

About two years ago a deposit of the mica-like vanadium mineral, accompanied by very little uranium, was discovered in sandstone that is probably of La Plata age, on East Rifle Creek, in Colorado, about 11 miles from the railroad. These deposits seem to contain large quantities of material that carries 3½ per cent V_2O_5 (2 per cent V). The United States Vanadium Co., which controls the deposit, has built a concentration and reduction plant at Rifle for the manufacture of vanadic acid and iron vanadate. Its plans include the erection of a plant in the East for the manufacture of ferrovanadium. The plant may afford an outlet for other ores of similar type that will bear transportation—for instance, some of the ores of the La Sal Mountain region. The Pittsburgh Radium Co. has established a plant in Denver for the reduction of vanadium ores from Yellow Cat Wash, 18 to 20 miles east and a little south of Thompson, Utah.

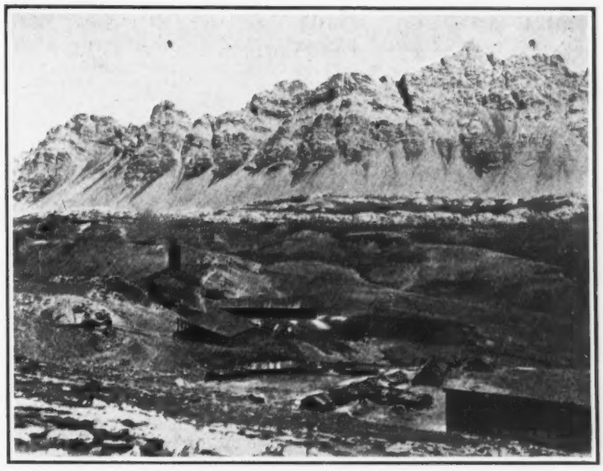
Roscoelite Deposits Found in Colorado

An ore somewhat similar to those just described is the roscoelite-bearing sandstone of La Plata age found and extensively mined near Placerville and Vanadium, in San Miguel County, Colo. These ores are very simple and have no deleterious minerals. Bodies of ore could be selected that carried 1.7 per cent V (3 per cent V_2O_5) through sandstone from 1 or 2 in. to a maximum of 36 ft. thick. The bodies were generally flat lenses, and some were several hundred feet wide. The Primos Chemical Co. worked with a plant at Vanadium for producing hydrous iron vanadate, which was shipped East for reduction to ferrovanadium. For a while men of smaller capital mined pockets of the ore that carried 3 per cent metallic vanadium for shipment to England. Afterward the Colorado Vanadium Co. established a plant at Sawpit. Then the Primos Chemical Co. sold its property and business to the Vanadium Corporation of America, which later closed the property. Still later the Colorado Vanadium Co. was forced to close, and no work has been done in the area for several years. Opinions differ markedly as to whether important quantities of ore remain. At any rate, the area does not now furnish competition in the vanadium market.

The two types of plateau deposits described, wholly unknown elsewhere, produced from 1911 to 1922, inclusive, 4,345 tons of vanadium, against 6,502 tons of vanadium in shipments of ore from Peru.[2] In a personal letter Prof. W. Spencer Hutchinson estimates that to the end of 1923 about 2,100 tons of the American vanadium and 5,768 tons of the Peruvian vanadium reached consumers.

Lead Vanadates Are Commercial Sources

The most widespread vanadium minerals, and therefore those with which the greatest number of prospectors and miners come in contact, are the vanadium minerals occurring in the oxidized parts of lead veins. All are distinctly and many are brightly colored, so



Mina Ragra, Peru, where the mine of the Vanadium Corporation of America is located. The dry season is from May to October

that they attract attention, and as the prospector's business is to make money from minerals, when he finds these he wants to know whether he can turn them into cash. Vanadinite, which may be taken as the type mineral, contains lead, chlorine, vanadium, and oxygen. The other vanadium minerals also contain lead, but may contain other elements, thus: brackebuschite contains iron, manganese, and water, but no chlorine; dechenite contains no chlorine; descloizite contains zinc and water but no chlorine; cuprodescloizite contains copper, zinc, and water, but no chlorine; endlichite contains arsenic; and mottramite and psittacinite, which are probably the same mineral, contain copper and water but no chlorine. With the vanadium minerals is likely to occur, also, either pyromorphite, the lead chlor-phosphate, or mimetite, the lead chlor-arsenate, or both. In North America wulfenite, the lead molybdate, almost everywhere accompanies vanadinite.

There may be almost any combination of these minerals in a given deposit and a considerably different combination in another deposit close at hand. The deposits are usually small, so that no large tonnage can be produced from any one mine, and the metallurgy, difficult at best, is thus complicated, because processes must be rearranged for each new combination. It seems probable, however, that some process can be devised that will successfully treat all these lead ores. Under present practice smelters cannot afford to make the constant changes in their processes necessary to

[2]Official Peruvian figures.

treat comparatively small lots of ore from different mines. Although some foreign ores carry more, it is usually difficult to raise the content much above 8 per cent V_2O_5, so that freight charges are comparatively high. These facts show the reasons why the market for the lead vanadates has usually been poor. With improvements in metallurgy such as the precipitation by steam of V_2O_5 in the presence of phosphorus and arsenic,[3] the separation of small quantities of phosphorus from vanadium by sodium aluminate, and the increased skill in electric-furnace metallurgy, antipathy to these ores is waning.

Small quantities of American lead vanadates have been marketed from time to time, and it seems probable that more will be sold in the future. The Electrometallurgical Co., of Niagara Falls, N. Y.; the York Metal & Alloys Co., of 100 East 42d St., New York City; the Metal & Thermit Corporation, of 120 Broadway, New York City, and the A. C. Daft Company, of 945 Oliver Building, Pittsburgh, Pa., are at least tentatively interested in the lead vanadates.

Moreland gasoline locomotive with car on Vanadium Corporation of America's railroad in Peru between Ricran and Casa Laguna, a distance of fifteen miles

This road was graded in 1920 for trucks; the rails were put down in 1924. Shipments in 1924, 500 tons a month. The sacks contain vanadium ore.

Small quantities of vanadium have at times been produced from Spanish vanadinite, and recently considerable shipments of mottramite and descloizite have been made from Otavi, in the British Mandate in Southwest Africa. For a time the shipments were at the rate of 50 tons per month, but during the last year they are said to have been somewhat increased. These ores are said to carry about 10 per cent V_2O_5. An estimate of 1,000 long tons of vanadium in ores in sight has been reported. Official figures for shipments from the Mandate are: 1920, 365 metric tons; 1921, 660 metric tons; 1922, 646 metric tons. Other official figures vary widely.

Two or three carloads of vanadinite carrying about 12 per cent V_2O_5 have been shipped from Ottoshoop, in the Transvaal, and ores of similar richness have been shipped from Northern Rhodesia, as follows: 1921, 56 metric tons; 1922, 143 metric tons; and in 1923, 83 metric tons. Rhodesian ores received in this country are reported to carry 1 per cent of phosphorus. Eventually the South African ores are said to go mostly to the Thermo-Electric Ore Reduction Corporation, Ltd., of Luton, England, but some have come to this country and other lots have gone to Germany for extraction of vanadium oxide, which is said to be shipped to England. German firms have succeeded in making at a comparatively low price an excellent product, which has been kept out of this country by the high duty.

[3]Doerner, H. A.: "Separation of Arsenic and Phosphorus from Vanadium." *Industrial and Engineering Chemistry*, Vol. 15, October, 1923, p. 104.

Exports of lead vanadates from Africa in 1923 are officially reported to have been as follows:

Total Exports from Union of South Africa, Rhodesia and Southwest Africa for 1923

Country of Destination	Tons (2,000 lb.)	Value
United Kingdom	70	£3,270
Holland	321	10,410
Germany	1,301	57,370
United States	127	4,120
Totals	1,819	£75,170

Occasionally some lead vanadate has also been shipped from northwestern Argentina, and some has been shipped from the Aurora mine of the Madero estate, in northeastern Chihuahua.

Minette Ores

The first vanadium salts isolated commercially are said to have been made from the slags of the minette ores—sedimentary brown iron ores—in eastern France. These ores carry as much as two- or three-tenths of 1 per cent of V_2O_5, which goes into the slags of the blast furnace, from which it has been collected at various times, though it is not known that any is being saved now. The form of the vanadium is unknown.

Ilmenite

Vanadium is found in ilmenite in quantities varying from a trace to 0.36 per cent of V. The form of the vanadium in ilmenite is unknown. At one time a company interested in mineral products carried out a rather extensive investigation of the ilmenitic iron deposits with the object of ascertaining their value for vanadium. The conclusion was reached that the vanadium probably can be extracted profitably when vanadium sells at $6 or more per pound in ferrovanadium. There is no known present probability of production from this source.

Phosphate Rock

A possible competitor for market is the vanadium contained in the phosphate rock of Idaho, Montana, Utah, and Wyoming, in which it occurs in quantities ranging from 0.06 to 0.29 per cent V (0.11 to 0.52 per cent V_2O_5). When the rock is dissolved the vanadium also goes into solution, and it seems possible that it may be extracted profitably should rock be treated at the rate of 1,000 tons per day, as is planned. There is a potential supply here of more than 400 tons of vanadium per year, but the technical difficulties may be insurmountable.

Petroleum

Nearly all petroleums carry some vanadium in the ash. The ash, however, is low, probably in general about 0.01 per cent of the whole. DeGolyer[4] says, "Vanadium occurs in Mexican oils in such quantities that at one time the possibility of burning coke from Mexican crudes and extracting vanadium from the ash as a commercial proposition appeared feasible enough to receive serious consideration," but he does not give the quantity of ash in the petroleum nor of the vanadium in the ash. Analyses of ash made by the U. S. Geological Survey on coke from petroleums have not so far indicated supplies from which vanadium can be drawn under ruling prices.

Asphaltites

Vanadium was found with asphaltites in various parts of the world—the United States, Cuba, Sweden (there

[4]DeGolyer, E.: "The Occurrence of Vanadium and Nickel in Petroleum." *Econ. Geol.*, Vol. 219, 1924, p. 552.

called "kolm"), Argentina, and Peru before it was known that petroleums carried the element. The vein asphaltites in this country carry only about one-tenth of 1 per cent V_2O_5 (0.06 per cent V), but Peruvian asphaltites carry as much as 1.0 per cent V_2O_5 (0.78 per cent V).[5] When an asphaltite is burned any vanadium contained collects in the ash. The ash is usually low, but it may be very high, and some ash is as much as 20 per cent V_2O_5, but as it is very difficult to burn the ash free from carbon, the output is of lower grade. It is these asphaltites, mistaken for coal, that have given rise to the numerous references to vanadium in coal. The largest deposits are in the province of Yauli, Peru, where the asphaltite has been used in large quantity as a substitute for coal. Some tons of ash are reported to have been shipped to England about twenty years ago, and some has been shipped to the United States during the last few years, but the total quantity of vanadium contained is small. No large output in the near future seems probable.

Vanadium Also Found in Carbonaceous Shales

A potential source of vanadium is in a carbonaceous shale found in the province of Jauja, Peru. The shale is more than 30 ft. thick and has a great length of outcrop. The shale contains much smutty black material, phosphate nodules and fossil ammonites. Baragwanath[6] says that the shale has an average content of more than 1 per cent V_2O_5 (0.56 per cent V). The vanadium can be concentrated by separating the phosphatic nodules, which seem to contain most of the metal. This shale deposit is so large that, should demand justify, very large operations could be carried on, possibly with a reasonable cost for the output.

Vanadium has also been reported as occurring in quantities amounting to 0.5 per cent V_2O_5 (0.28 per cent V) in carbonaceous shales accompanying coal beds in the United States, but their investigation has not yet proceeded far enough to warrant definite statements.

Although, as I have already stated, most of the reports of vanadium in coals have come from mistaking asphaltites for coal, some coals have been found to carry vanadium and perhaps many others will be found when more careful examination of the ash is made. Frank L. Nason, in his discussion of DeGolyer's paper, referred to under "Petroleum," said that he had found a coal bed in Nueva Leon which carried 5 per cent ash, of which 25 per cent was V_2O_5 (14 per cent V). He also found coals from Newmire (now called Vanadium), Colorado; the Richmond Basin, in Virginia; and Carboniferous coals from the Central, Eastern and Southern states to carry from 0.05 per cent to 0.1 per cent V. Under present circumstances none of these coals are workable for vanadium.

Summary of Present Production

From a perusal of the brief outlines given of the present and prospective vanadium supplies, it will be seen that at present the Peruvian vanadium deposit at Mina Ragra is the predominating factor in vanadium supply and the operating company, the leading firm among the world's dealers in vanadium, has all the ore it can use for the present. Competition is at the moment confined to a comparatively small quantity of byproduct vanadium from radium manufacture, and to comparatively small quantities of vanadinite and related minerals from South Africa. Under improved metallurgy there is now some chance, and there will probably be more opportunity soon, to market vanadinite and related minerals from the Southwest. There is possible future competition for the market from the phosphate fields of Idaho and adjoining states.

When the now known richer ores are exhausted, vanadium can be produced in large quantity at reasonable cost from carbonaceous shales and possibly from ilmenite.

Ferrovanadium

Ferrovanadium is made in this country by the Vanadium Corporation of America, 120 Broadway, New York City; the Standard Chemical Co., Forbes St. and Meyran Ave., Pittsburgh, Pa.; the Electrometallurgical Co. of America, 30 East 42d St., New York City; the Metal & Thermit Corporation, 120 Broadway, New York City; and the York Metal & Alloys Co., 100 East 42d St., New York City. The first two companies have their own ore supplies, but the other three have to buy their ores. The York Metal & Alloys Co. and the Metal & Thermit Corporation have operated mostly on oxide or iron vanadate made as a byproduct in the isolation of radium. All the companies except the Metal & Thermit Corporation use electric furnaces in reducing their ores. The Metal & Thermit Corporation uses the alumino-thermic process. The five companies supply the American demand, and ferrovanadium is also exported to Europe, as the South African ores, practically all that Europe gets, do not supply its needs.

Transportation before the Vanadium Corporation's railroad was built

Llamas loaded with vanadium ore leaving Mina Ragra for Ricran, 28 miles away. Tonnage capacity of this method of transportation limited to 250 tons monthly, being restricted by the amount of pasture for the animals.

As in all other ferro-alloys, the general requirements are that phosphorus and sulphur shall be low and preferably that silicon and carbon shall also be low. Impurities may be higher than in most ferros, because very small quantities of ferrovanadium are added to steels. In electric-furnace work, carbon is likely to be high, although it can be brought down to 0.5 per cent or less, as low as the alumino-thermic process gives. It is difficult to make the ferro carry more than 40 per cent of vanadium, and except in special brands ferros carry between 30 and 40 per cent of vanadium.

The Vanadium Corporation of America makes three

[5] Hewett, D. Foster: "Vanadium Deposits in Peru." *Trans.*, A.I.M.E., Vol. 40, 1910, pp. 274-299.

[6] Baragwanath, John G.: "The Vanadiferous Asphaltites of Central Peru." *E. & M. J.*, Vol. 111, 1921, pp. 778-781.

grades of ferrovanadium, the names and specifications of which are as follows:

Open-Hearth Grade

	Per Cent
V	30 to 40
Si, less than	15
C, less than	6
S, less than	0.50
P, less than	0.20

Price (May, 1924), $3.50 per pound of contained V.

Crucible Grade

	Per Cent
V	35 to 40
Si, less than	8
C, less than	3
S, less than	0.30
P, less than	0.15

Price (May, 1924), $3.60 per pound of contained V.

Primos Special

	Per Cent
V	35 to 45
Si, less than	3.0
C, less than	0.50
S, less than	0.30
P, less than	0.10

Price (May, 1924), $3.75 per pound of contained V.

At an increased price a ferrovanadium can be produced that has still smaller percentages of impurities. Thus, Si can be reduced to 1 or 2 per cent, S to about 0.1 per cent, and P to about 0.06 or 0.08 per cent.

The Standard Chemical Co. makes only one grade of ferrovanadium, and for it the specifications are:

	Per Cent
V	33 to 40
C, (maximum)	0.75
Si, (maximum)	4.00
P, (maximum)	0.12
S, (maximum)	0.03

The silicon content can be reduced to 2 per cent maximum. The Metal & Thermit Corporation also makes only one grade of ferrovanadium, with the following specifications:

	Per Cent
V, (average 38 to 39)	35 to 40
Si, less than	1
C, less than	0.5
S, less than	0.06
P, less than	0.08

Some manufacturers demand specifications similar to those above noted, but make the carbon 0.20 to 0.50 and add that the ferro shall contain no chromium nor tin. Chromium might be present when the ferro is made from some vanadinites, but tin, so far as I know, is an unknown item in vanadium ores.

Ferrovanadium is ordinarily sold in four sizes: Egg size, used in the electric furnace and in acid open-hearth furnaces; 1¼-in. size, used in the electric furnace, in crucibles, and in basic open-hearth, ladle additions: wheat size, used in crucibles; and fines, passing a 20-mesh sieve, used in electric furnaces, crucibles, and in steel and iron foundries. Size does not affect the price.

Ferrovanadium is shipped in stout kegs about 16 in. high with ends 12 in. across. The kegs contain 165 lb. of ferrovanadium and weigh about 12 lb. apiece.

Prices are, of course, the vital consideration, and are difficult to discuss with any degree of satisfactory accuracy. Ordinarily, they vary little or none with the quantity of ferrovanadium bought, unless it is very small or very large. Before the Great War, the Ford Motor Co. was the greatest single user of vanadium, and as such it was reported to receive a considerable concession from ordinary prices.

The war made a great rise, from about $2 to $6 or $7 a pound for the contained vanadium, and the Ford Motor Co. practically ceased to use vanadium. It is probable that both the ferro makers and the buyers of Ford cars lost through the cessation of the contract.

Where buyers are few and the largest have a supply of their own ores conditions are especially hard for the producer of limited means, and sales are usually a matter of bargaining.

In 1919, with ferrovanadium low in silicon and low in carbon selling for as much as $9 per pound of contained vanadium, ores carrying as much as 10.83 per cent V_2O_5 sold for 60c. per pound for the contained V_2O_5, yet roscoelite ores of only 2.32 per cent V_2O_5 sold for $1 per pound of contained vanadium.

In 1920, with ferrovanadium low in silicon as high as $8.50 at the beginning of the year and $5.50 at the close, ore carrying 1.06 per cent U_3O_8 and 4.68 per cent V_2O_5 sold for $1.30 for the contained V_2O_5, and ore carrying 0.92 per cent U_3O_8 and 15.16 per cent V_2O_5 sold for 67.7c. per pound for the contained V_2O_5.

In 1921, with low silicon ferrovanadium in January at $6.75, dropping to $4.50 in December, clean ores carrying 4 to 5 per cent V_2O_5 brought 25 to 30c. per pound for the contained V_2O_5.

In 1922, with high-grade ferrovanadium selling at $4.50 to $5, no domestic ore was sold, but iron vanadate carrying 32 per cent V_2O_5 was sold at 36 to 75c. per pound of material and fused vanadium oxide carrying 75 per cent V_2O_5 was sold for $1.40 per pound.

These figures show erratic prices and indicate that sales reflect the immediate need of the buyer and are always a matter of bargaining.

The comforting part of the situation is that vanadium has become a staple in the manufacture of good steel, and its future demand in a direct ratio to the manufacture of steel is apparently assured.

Dolores Mine in Chihuahua, Mexico

Useful Operating Ideas

Care and Use of Rock Drills

Weak rotation and loss in drilling speed from other causes than lack of oil, state E. R. Borcherdt and H. D. Sultzer in an article in the *Anode,* may be due to loose or unevenly tightened side rods, permitting loss of air through the front head. The side rods should be drawn up snug, but not tight enough to compress the springs. If the piston strikes the heads when the springs are compressed, there is danger of breaking the side rods, and if the machine has lost its cushion due to defective valves or worn cylinder washer, the front head will, sooner or later, be broken. A machine which continually strikes the heads, even when cranked up against the ground, should be sent to the shop for repairs. In drilling in soft ground or vug holes, or when reaming a hole, it is necessary to hold back on the crank, at which times running with a half-open throttle is most satisfactory. The maximum drilling speed is obtained when the machine is cranked to the ring of the steel. Crowding the crank shortens the piston stroke, weakens the rotation and grinds off the cutting edges of the bit.

A bent feed screw makes extra effort necessary in cranking and is usually caused by dropping the machine and allowing it to strike on the end of the front head. It is sometimes damaged by slapping around in the shell when the feed screw support nut has been removed in order to gain several inches in the feed.

Oil plugs should be kept tight. If the front head or cylinder plugs are lost, the drilling speed is slowed up and the machine will not retain oil. If the nuts on the lubricator or valve bolts become loose, care is necessary not to draw them up too tight, as the end of the bolt is readily twisted off with a large wrench.

Rubbers especially made for the water spuds are available, and, if slightly too long, they will close the holes in the brass screen when the water connection nut is tightened. If this occurs, remove the rubber and cut off an eighth or a sixteenth of an inch and replace it. The use of red rubber gaskets in the water spud is to be discouraged, because they are readily cut by the water-connection nut, and frequently plug the screen and tube.

Proper alignment of the drifter machine and steel is of utmost importance. Running a machine out of line slows up the drilling speed and increases the chance of sticking the steel, besides putting additional strain on the rotation and contributing to piston breakage. A miner who spends a few extra minutes on each hole in keeping his machine in line will drill many more holes in the shift than one who fights the hole through without regard for line. It is best not to drill with a loose swing clamp. This might be justified in finishing a tight hole, but as a general practice it will result in lost time.

In drilling "down holes," if too much water is used the coarse cuttings will stay in the bottom of the hole and pack around the bit, while the finer material runs off with the water. This is the cause of many cases of stuck steel, especially when square steel is employed, and it will be found helpful if less water is used so that the cuttings will form a thin mud, which can be more readily removed by the machine. Closing the water valve for an instant while holding back on the crank will help "mud" the hole by permitting a larger amount of air to get to the bottom of the hole and blow out the cuttings. In soft "down holes" it is essential to hold the steel off the bottom of the hole until the water has a chance to get to the end of the steel.

The water tube for a round-steel drifter is 2 in. shorter than the one used in the square chuck machine and occasionally the wrong length tube gets into a machine and causes trouble. If the short tube is used with square steel, it does not project into the steel, and most of the water, instead of getting to the bottom of the hole, leaks out of the chuck. If a long needle is put into a machine requiring a short one, the tube will project too far into the steel and is likely to be damaged.

Although the steel going into a mine may be as near perfect as possible, occasionally a hard or soft shank will slip by undetected and cause trouble. This can be avoided by the miner inspecting the shank end when selecting his steel. It is not worth while taking a chance on using a shank that is upset on the end and does not enter the chuck freely, for, after using, it may be impossible to remove it, and the machine must be sent on top. If shanks upset in the machine, the trouble may be caused by a cupped or chipped anvil block. If upsetting occurs around the water hole, a sharp bur is formed, which may cut off the water tube. This does not apply to stopers, as an anvil block is placed between the steel and the piston, and the water tube does not project above it. A chipped shank usually indicates that it is extremely hard and very likely to chip further and cause damage to the machine. Sparks from the chuck of an anvil block machine indicate that there are steel chips between the steel and the anvil block. The machine should be immediately stopped, before damage to the water tube or anvil block results. The end of a broken piece of steel should never be put into a machine.

In extremely abrasive ground, rapid wear of the gage of the steel is a serious problem and a large per cent of time is spent in making steel changes. The maximum distance that one steel can be run, regardless of other factors, is determined by the length of the feed of the machine, which varies from 18 in. in stopers to 24 and 30 in. in drifters. However, the maximum practicable distance a steel may be run is governed by the gage loss which will permit the next steel to follow. This point is sometimes indicated by the bit beginning to bind in the hole, but frequently when the binding point is reached the gage will have been worn so much that the next steel will not follow to the bottom of the hole, and reaming is necessitated. The so-called ream-

ing results in only slight enlargement of the hole, but wears off the gage of the new bit excessively, so that its useful drilling life is shortened before the bit reaches the bottom of the hole and the gage will be completely gone before the hole is deep enough to receive the following change. Had the first steel been used only for the distance necessary to make the change, the bottom of the hole would have been of sufficient diameter to accommodate the following gage change without reaming and the hole could have been advanced with considerably less expenditure of time and energy.

In the most abrasive ground it has been found that a bit will retain its gage enough to permit following without binding, when a 12-in. run is used. In order that this shorter change be used to best advantage, it is imperative that not more than 12 in. be drilled with each steel, except the finisher, which may be run until it sticks. With the six changes, the standard used at the Anaconda mine, a hole of something over 6 ft. can be drilled in the hardest ground, even where white quartz vug holes are encountered. Where hard ribs are only occasionally encountered, and in which an 18-in. change cannot be made without resorting to reaming, the use of two sets of steel, changed alternately every inch or so, will make it possible to bottom the hole. The number of times the steel is changed is greater, but the total time required to drill a 5-ft. hole was only 30 minutes, as compared to 50 minutes where a single set of drill steels was used.

When it is necessary to pound the steel, as it is at times, it is essential not to damage the machine by striking the front head or cylinder. A great deal of unnecessary pounding can be avoided if proper care is given the machine and the steel is changed as soon as the gage is gone.

Miners at times receive machines from a shop which are not in first-class operating condition, and this has given rise to the belief that machines sent to a shop for repair frequently receive little more attention than a dose of oil. This, however, is not the case, as each machine is taken apart and is put in what is believed to be first-class order before it is returned to the mine. However, it is sometimes difficult to locate the trouble, and what may appear to be good running order in the shop may be unsatisfactory under actual drilling conditions. The miner can assist in eliminating this trouble if he will tell the nipper why the machine is being sent to the shop, so that the repairman will have some idea of what he is expected to do.

Repair of Conveyor Belts

At the coarse-crushing plant of the Moctezuma Copper Co. at Nacozari, Mexico, a piece of tramp drill steel became wedged between the jaws of a double-pole magnet suspended above a 53-ft. conveyor in such a way that the belt was neatly cut for half its entire length before the motor could be stopped. The two halves slipped upon each other a distance of several inches. Strips of 6-in. transmission belting were riveted to the upper and lower sides and, thirteen months later, the conveyor is still giving excellent service. Wooden blocks have since been inserted between the jaws of the double-pole magnets to prevent the recurrence of a similar accident.

Extension Tracks for Drifts

In mucking out drifts, crosscuts, and adits, cars are brought as close to the face as possible to facilitate loading. To bridge the gap between the end of the track and the muck pile and to enable the cars to be moved up as the broken rock is removed, slick sheets are sometimes used, but a better device is an extension track. Three designs are shown in the accompanying illustration. Fig. 1 and Fig. 2 are the usual arrangements. In Fig. 3 two angles are used. In Fig. 1 the extension rails are turned upside down and held to the track by clamps. Two types of clamps are shown, both of which have been used. In Fig. 2, the extension rails are turned on their sides and the heads placed against the flanges of the rails. Blocks and wedges are used to hold them in place or the two extension rails can be held at the proper gage by rods that are bolted to the flanges.

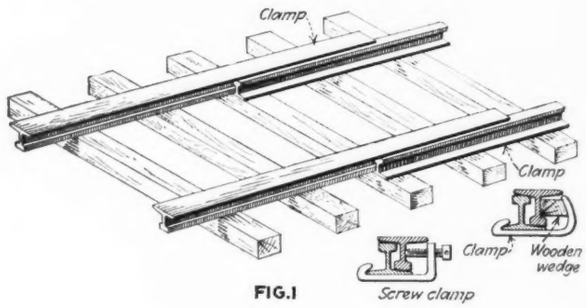


FIG. 1

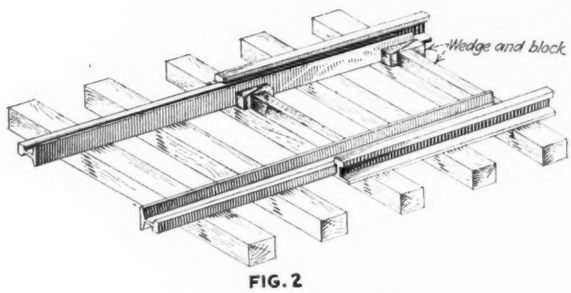


FIG. 2

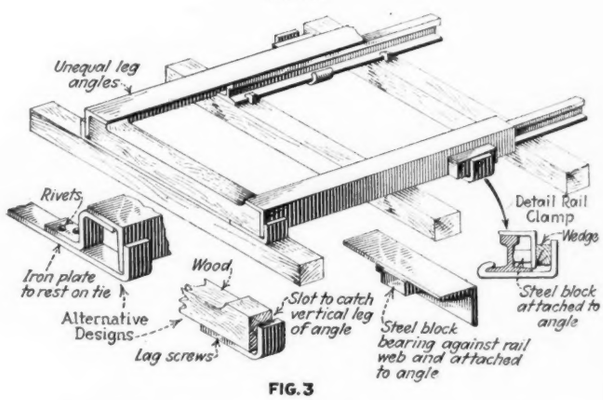


FIG. 3

Three different types of extension tracks for use in drift headings

In Fig. 3 the angles were provided with steel blocks that bear against the web of the rails and are held by a simple clamp. The extended angles are supported by a special steel tie or by a wooden tie to which is attached a heavy flat plate bent to form a slot to receive the vertical leg of the angle.

Discussion

Pyrite as Fertilizer

THE EDITOR:

Sir—Referring to the article in column 1, on page 470, Vol. 118, No. 12—the Sept. 20, 1924, issue of *Mining Journal-Press:* The value of sulphur as fertilizer, though recognized probably as far back as Roger Bacon, and widely employed in the United States for at least a half century, was placed upon a scientific foundation with the experiments conducted in 1913-14 by F. C. Reimer, superintendent of the Southern Oregon Experiment Station, Talent, Ore. Please refer to station Bulletin 163, issued in July, 1919, and obtainable from Oregon Agricultural College, Corvallis, Ore. Reimer found that phosphates, superphosphates, and nitrate commercial fertilizing mixture possess no virtue in Jackson County soils other than a modicum proportioned to the percentage of sulphates with which they are contaminated. He demonstrated also that raw ground sulphur is the most efficient soil dressing, and that in a calcareous or magnesian soil deficient in natural available sulphur the increase resulting from the application in autumn of sulphur will in the case of alfalfa and legumen range between the incredible figures of 200 to 300 per cent by weight, and a comparable increase of quality or protein percentage. One dollar's worth of sulphur at 2c. a lb. this year augmented the yield per acre of alfalfa $100, or five tons at the market price, $20.

Notwithstanding the date of the above-noted discovery, the agricultural Western world has marked time for ten years, with, so far as I can learn, the exception of a few counties in Oregon. Jackson County imports of raw sulphur have been $100,000, or about $10,000 a year. The State of Oregon takes perhaps $50,000 worth of sulphur for fertilizing each year.

It was early found that ground pyrites applied in double doses to equalize the sulphur content makes an economical substitute for elemental sulphur on the field, as may be noted in the bulletin mentioned above.

The *Mining & Scientific Press* five or more years ago published extensive articles on this subject, which is of immediate interest to miners owning pyrite waste dumps or suitably located pyritic minerals.

Medford, Oregon. F. W. CARNAHAN.

The Quicksilver Tariff

THE EDITOR:

Sir—Apparently one of your correspondents is again under strain because "less than one-third of the quicksilver requirements of the country are being supplied from domestic sources," and because "disinterested opinion is that the principal effect of the tariff is to permit further depletion of the mines."

It would appear the smaller the domestic output the less the depletion, but at any rate the Congress that fixed the tariff rate had little thought of building up a large industry—the total consumption of the country being only 2,000 flasks monthly; but Congress did consider it wise, notwithstanding the continued squawks of the New York importing interests, to keep a few of the quicksilver mines open. This was not due to any particular consideration for this old mining industry, but because the possible war requirements mentioned by your correspondent might perhaps be met better if a few mines were open than if they were all caved in and abandoned.

The import duties to which your correspondent objects mean just that much less other taxation, and it also seems certain that with the tariff removed or reduced, the Spanish and Italian producers who control the remainder of the world's production would promptly advance prices, and the American consumer would therefore derive no benefit from the tariff reduction.

All these considerations were most carefully studied and discussed by the Congress in both House and Senate and in committee, and it might do no harm if your correspondent and the disinterested observers he mentions would review the "Congressional Record" and thus become more familiar with the facts.

San Francisco, Calif. MURRAY INNES.

THE EDITOR:

Sir—Referring to the article on the quicksilver tariff in your issue of Sept. 27, 1924, the author would make it appear that no benefit had been derived by the tariff protection of 25c. per pound to the quicksilver industry. Since the present rate has been effective quicksilver mines that were closed down completely on account of insufficient tariff protection have been able to operate and are today producing regularly. They have also been able to develop new orebodies, which means the further extended life of the mines.

Though the duty of 25c. per pound has allowed this work to be accomplished, the rate asked for by the industry—namely, 35c. per pound—would have allowed that much additional to expend on development, and would also have enabled many other properties that are at present idle to develop their lower-grade orebodies.

Although in some kinds of mining, the regular operations deplete the ore reserves, it is a fact that the quicksilver mines which have been able to finance and open up their properties have developed much more ore than has been consumed in producing quicksilver, and a continuation of the present tariff will enable the producers to develop additional reserves, which will mean a continuation of this comparatively small but vital industry.

In 1923 government records show that domestic production was 7,937 flasks, an increase of 25 per cent over the production of 1922. The year 1924 will show an increase of about 75 per cent over the 1922 output, or a total estimated production of 11,000 flasks.

When the present tariff bill was being framed, the opponents of any duty on quicksilver brought forth the same argument as does the author of your article, and the War Department was so strongly against the propo-

sition to close the domestic mines by an inadequate tariff that Secretary Weeks of the War Department instituted a special investigation of the industry, which resulted in his sending a request to both houses of Congress and to the Ways and Means Committee urging a proper protection to the industry, so that the mines may be further developed and continued as a key industry.

Looking at the question from the point of view of consumers or users of quicksilver, without the domestic production constantly coming on the market these consumers would be entirely in the hands of foreign producers and importers, and many of the larger users have personally expressed to me their satisfaction in having a sufficient tariff duty on quicksilver so that the domestic production could be continued. As a matter of fact, the price of quicksilver, whether $1 per pound or double that, has very little effect on the price to the average citizen of this country, the ultimate consumer. For instance, a clinical thermometer selling at $2 retail contains approximately one-half a cent's worth of quicksilver. In the manufacture of detonating caps, 1,000 caps contain only 1.6 lb. of quicksilver. These caps sell for $14.75 per thousand, and the total amout of tariff involved is 40c.

So often in arguments against a protective tariff on particular articles, or against a protective tariff as such, the idea is conveyed that the money paid in tariff duties represents a loss or burden. It should always be borne in mind that every cent of money collected in tariff duty goes into the Treasury of the United States and lessens the necessary tax burden to that extent. In short, whatever money is collected through tariff from the people of the United States immediately becomes an asset to them by being funds in their own public treasury.

To sum up the situation, the market price of $1 per pound enables the domestic mines to continue production and develop known orebodies, and eventually create reserves that will be available for any reasonable demand of our government and the domestic consumer.

It is a recognized fact that there is in this country an enormous quantity of low-grade quicksilver ores which need only the stimulation of a fair market price to induce the investment of capital for development. The development of these ores is most important from three standpoints: First, increasing the proved ore reserves and assets of the mine owners; second, the development and marketing of an important national resource, and third, increasing known reserves for war emergency.

Boston, Mass. H. P. BAKER,
General Manager,
New Idria Quicksilver Mines, Inc.

Continuous Vacuum Filters in Cyaniding

THE EDITOR:

Sir—I have read with considerable interest Mr. Kelly's article on "Continuous Vacuum Filters in Cyaniding," appearing in the *Journal-Press* of Oct. 11. I agree with Mr. Kelly that vacuum filters perform an important function in any all-sliming cyanide plant, and I believe it is now generally conceded that the use of vacuum filters working in conjunction with a counter-current or a reduced counter-current plant is economically sound. The Hollinger has been operating its filter plant in connection with its counter-current system for more than a year, and if that company saw fit to make public its results, ample proof would be afforded to justify the filter installation. Following the counter-current decantation with filters has several advantages: (1) The number of thickeners can be reduced; (2) saving in dissolved values; (3) saving in cyanide; (4) saving in zinc dust; (5) saving in refining cost; (6) when using filters behind the counter-current system, the moisture in the residue sent to waste is compensated by the wash used, whereas it is necessary to replenish the solution circuit by a ton of water for every ton of solids sent out as residue from the counter-current decantation tanks when not followed by filters. During certain seasons this water must be brought up to a suitable temperature, as the capacity of the settling tanks is sensitive to temperature, as is also, to some extent, the solubility of gold.

The working out of the five flow sheets and the comparative cost of the different installations is informative. Mr. Kelly, after carrying on certain filter experiments, and after taking due note of results obtained at a certain plant using filters, states that he has come to the conclusion that "Vacuum filters operating in series are the most efficient device for separating the pregnant solution from the solids, after agitation." The conclusion reached does not seem to me to be sound. The fact that filters in series are used at one plant is no criterion. The statement that the dissolved values in the plant with the filters in series were practically nil is of little consequence unless all facts are known as to ore and solution values and many other details. The theoretical formula traced on flow sheet 5 did not show as complete displacement as was indicated by flow sheets 2 and 3.

In the drum filters it is practicable to get only an approximate displacement of the solution in the cake, because only a certain amount of wash can be added and drawn in through the filter cake; if an excess is added, it runs down the side of the filter. If this applies to a drum filter, it certainly would apply to a greater extent with a filter of the disk type, where the sides are steeper, but even admitting dissolved values at the Argonaut to be practically nil when using filters in series, there are still good reasons why it would not be safe to dispense with thickeners: (1) Mr. Kelly assumes that there is no dissolution of values in the thickeners. Not long ago I was shown some data on this very point, in one of the mills at Porcupine. It is of course generally known that some recoveries are made in the thickeners, but if the pulp had been taken to a filter direct from the agitators in the plant in question, repulped, and sent to a second filter, the losses would have been prohibitive. (2) If the filters are used back of the agitators, the pulp in the agitators would have to be maintained at a density of one of solution to one of solids. Such a high density tends to retard the dissolution of precious metals.

The double filter system is not so elastic as, nor does it offer the protection to fluctuating mill feeds that is given by, a system embracing both counter-current decantation and filtration. Just how many tanks should be in the counter-current system when followed by filters cannot be reduced to concrete figures, as all contributing factors must be carefully balanced in formulating definite conclusions. HENRY HANSON.

Toronto, Ont.

Continuous Vacuum Filters in Cyaniding

THE EDITOR:

Sir—I have read with considerable interest Mr. D. B. Kelly's article in your issue of Oct. 11. Mr. Kelly brings out some interesting figures and makes a strong case for double filtration. It is often difficult to avoid drawing erroneous conclusions from the most irreproachable figures, and, to some extent, I fear that Mr. Kelly has done this. It is with some hesitation that I question his conclusions, as my own knowledge of the Porcupine district ends with 1916, which is ancient history so far as costs go, although the ore and its physical characteristics should not have changed materially.

It may be well first to call attention to the fact that Mr. Kelly uses 50 per cent moisture in all underflows in his calculated flow sheets, whereas during the time that I was at the Hollinger we had no difficulty in averaging very close to 40 per cent moisture in our underflows. If similar results are not now being obtained it is doubtless because the Hollinger company finds it economically desirable to sacrifice metallurgical efficiency for increased tonnage. Flow sheet No. 1 recalculated on the slide rule gives a value for Z of 0.051, as against 0.0978 shown by the 50 per cent moisture flow sheet. Further, as only 67 tons of this lower-grade solution goes to waste, with 100 tons of ore the loss would be per ton .67 x .051, or .0342, against .0978 shown by Mr. Kelly.

Further, Mr. Kelly makes the unsupported assertion that the actual dissolved loss is about 7c. greater than the theoretical. This is not supported by actual figures, which I shall quote later, but I believe that this impression was gained from the fact that the flow sheet as usually calculated assumes that dissolving ceases when the pulp leaves the agitators. This is seldom or never the case in practice. Though the major part of the values dissolved in the thickeners is recovered, the remainder goes to swell the dissolved loss, although these are values that would go out undissolved in a plant where the time of contact was less. In this fact lies one of the outstanding advantages of counter-current decantation, yet, unfortunately, its results are often quoted to the detriment of the process.

I have before me my old Hollinger note book in which I find a sampling of the solutions overflowing and filtered from the underflow of each of the tanks in the plant existing in November, 1916. The first three units show about 7c. higher in the underflow solutions than in those overflowing for the W tanks, and the X, Y, and Z tanks show 3, 2, and 2c., respectively. Adsorption does not explain this difference as I see it, but continued dissolving does. Another fact that goes to prove this is that the differences in the remaining two units were much higher (as much as 18c. in one W tank). The feed to these two units contained a part of the pulp that unavoidably bypassed the agitators, so that additional dissolving in the thickeners was to be expected. This constitutes an apparent enrichment of the solutions to the extent of about 12c., excluding the Z tanks, and corresponds to 8c. per ton of ore. A five-day average of the soluble loss for the five units during this test showed 11.5c. per ton of solution lost, corresponding to 7.66c. per ton of ore soluble loss. This would indicate then that the values dissolved during the decantation were equal to the total of the dissolved loss and that the values going to precipitation equaled the total in solution when the pulp left the agitators. It might be added that these results were obtained before the Crowe vacuum process was available and the average values in barren solution were 3c. per ton, compared with the 1c. used in the theoretical flow sheets. A reduction of 2c. in barren-solution values would reduce the above dissolved loss by 1c.

It must be admitted that the capacity of the decantation plant has a very fixed limit, which cannot be exceeded without heavy penalties in lost values, but when this has been said I cannot see any advantage for the filters over decantation in the recovery of dissolved values. Indeed, without the somewhat remarkable wash absorbing power mentioned by Mr. Kelly, the account might even reverse itself. The filter has an undisputed advantage in the way of cyanide saving, but it is questionable whether this would offset the considerably greater operating cost of the filter except in the largest installations.

L. B. EAMES.

Denver, Colo.

Charles Hoyle; and Esperanza Mining Co.

THE EDITOR:

Sir—On Sept. 9 the secretary of the Esperanza Mining Co., in London, issued a circular letter to shareholders of that company, in which reference was made to the former manager, Mr. Charles Hoyle, in a most undignified, abusive, and uncalled-for manner. The history of Mr. Hoyle's connection with that company is as follows: He became connected with the company immediately after the purchase by the English company, first as engineer, then as assistant manager, and then manager, being in technical control of the mine for more than eighteen years. During this time, and in great part owing to his efforts, the company paid dividends of twelve million dollars, on a capitalization of £455,000. Any mine becomes worked out in time; so that Esperanza, after having been at one time among the foremost producers of gold in the world, reached the point where production did not cover expenses. Mr. Hoyle then proposed that the company make one more effort—to attempt by increased milling capacity to treat a sufficient quantity of low-grade ore to make a profit of 50c. per ton. The ore which he proposed to treat was composed principally of filling of the old stopes, a material hard to estimate as to quantity and impossible to sample with any degree of accuracy.

The London office, no doubt noting the narrow margin of safety in the calculations, asked Mr. Hugh Rose to check up the estimate. I do not know the details of this checking up, but according to the letter cited, Mr. Rose agreed with the estimate so far as it referred to operations, but for the reasons that I have stated above, showed that it was impossible to estimate closely the value of the ore. With this information at hand, and knowing the risk involved, the London office advanced the necessary money to increase the capacity of the mill to 1,000 tons per day, the capacity recommended by Mr. Hoyle, and resumed milling. The results expected failed to materialize, and the monthly balance became one of red ink. Mr. Hoyle then resigned from the management. No doctor can keep a patient alive indefinitely.

The London office loses sight of the extremely profitable years of the mine, under the administration of Mr. Hoyle, and attempts by passing the buck to avoid any responsibility in the matter.

FRED. MACCOY.

Mexico City, Mexico.

News of the Week

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Summary

THE Anaconda Copper Mining Co. has resumed operations at its Pennsylvania mine, one of the largest copper producers in Butte. The shaft is to be sunk from the 2,900 to the 3,600 level.

Shipments of zinc concentrate from the Joplin-Miami district for the week totaled 12,380 tons—somewhat below production. The price increased from $42.50 to $43.

Approaching exhaustion of the Hercules mine in Idaho has led to an intensive search for other properties by the owners. Dividends total $18,000,000.

The Wright-Hargreaves Co. is increasing the capacity of its mill at Kirkland Lake, Ontario, to 400 tons per day. Output for the first six months was $440,000.

The Mason Valley Mines Co., in Nevada, is constructing a tramway from its mine to the Bluestone mill, recently acquired, with the expectation of starting production.

It is reported that the Sunnyside mine of the United States S. R. & M. Co., in Colorado, has three years' ore supply at present rate of 20,000 tons per month.

High prices for lead, silver, and zinc have renewed activity in the Kootenay district, in British Columbia. The Bluebell, Florence, and North Star mines will be reopened.

At Jerome, Ariz. the United Verde Copper Co. has finished its No. 6 shaft to 2,400 ft. A novel method of concreting was employed.

Hercules, Earner of $18,000,000, in Idaho, Nears Exhaustion

Discovered Twenty-two Years Ago—Made Millionaires—Searching for Mine to Perpetuate Company

The Hercules mine, in the Coeur d'Alene district, Idaho, is nearing the end of its remarkable career. Its discovery about twenty-two years ago and its quick transformation of a group of poor men and women into millionaires served as the setting for one of those fascinating stories which have ever provided a halo of romance in connection with mining in the Far West. The Day family principally was interested.

Up to less than a year ago the Hercules was operated as a partnership made up of the original owners, and operating affairs have been closely guarded. For this reason the actual dividends paid by the mine have always been a matter of estimate. It is believed, however, that since the discovery twenty-two years ago the Hercules mine has paid not less than $18,000,000.

Doubtless in anticipation of the exhaustion of the mine, the Hercules Mining Co. was incorporated within the last year, since when the company has adopted a policy of expansion which promises to result in the development of other mines. The company owns the control of the Ambergris mine, joining the Hercules on the north, which has been developed by crosscutting from the Hercules workings. Just what the showing is in the Ambergris is not known, but according to reliable information there is a considerable tonnage available. The Hercules owns a large group of claims known as the Maher-Hearn, lying east of the Hecla, with two claims owned by the Gertie Mining Co. between. The Hercules recently purchased control of the Gertie, so as to secure the Gertie crosscut tunnel, 4,000 ft. long, which extends practically to the Maher-Hearn line and makes that property easily accessible for development. The company has also recently secured control of other properties, which, with its already large holdings of undeveloped ground, suggests that the Hercules may again become a big dividend payer.

Sunnyside Has Ore for at Least Three Years

DEVELOPMENT work during the past summer on the Washington lode of the Sunnyside Mining & Milling Co., operating at Eureka, San Juan County, Colo., has resulted in an increased output. For the last nine months the average monthly production has been 18,000 tons of ore, but this month's production will be more than 20,000 tons. It is estimated that ore reserves have been developed that will maintain this output for at least three years more.

The ore is a lead-zinc sulphide, with gold, silver, and copper. The selective flotation process at the mill makes two products, lead and zinc. Lead concentrate and a middling product are shipped to the Durango smelter, and the zinc concentrate is sent to the oxidizing plant at Blend. The ratio of concentration is about five to one.

Baxter Springs Busy Sector in Joplin-Miami Field

Annex Mining Co. Has New Derrick—Much Development — Miller Mill Moved—Lease Brugger Mine

The Baxter Springs section of the Joplin-Miami zinc-lead district is the scene of new activity. In the Sunnyside district, south of Baxter Springs and east of Picher, the Annex Mining Co. has recently erected a derrick and hopper, after development work, and plans further development. The Vinegar Hill Zinc Co. has completed its shaft on the Coyne land and is continuing drilling operations in the vicinity. George Moore and associates are developing a promising property to the south of the Annex. Nichols and associates have recently purchased the Miller mill, southwest of Joplin, and are moving it to a location south of the Annex.

J. W. Grantham, C. E. Youse, and associates, of Baxter Springs, have purchased the fee of 110 acres of land a short distance west of Baxter Springs for a consideration of $35,000. The property contains the Ebenstein mine of the Chanute Spelter Co., and other properties, but the northern part of the tract has not been deeply drilled and is believed to contain orebodies. The Chanute company recently abandoned its operations at the Ebenstein property.

The Vantage Mining Co. has obtained an option on the Brugger mine, north and west of Baxter, and is sinking a prospect shaft and will complete some drilling during the sixty-day option. The mine is owned by Tom Bailey and associates.

United Verde "Man" Shaft Deepened to 2,400 Ft.

The United Verde Copper Co. has completed the extension of its No. 6 shaft from the 1,950 level to the 2,400 level. The shaft's inside measurements are 13 by 13 ft., comprising compartments for hoist, pipes, manway, and counterweight. The formation through which the shaft passes is so solid that support for the walls is unnecessary. The cage guides, pipe lines and electric cables are fastened to rings of reinforced concrete which are secured to the walls by iron dowel pins. The rings are 2½ ft. wide and 8 in. thick and are reinforced by seven ¾-in. steel bars. The interval between rings is 3½ ft.

In placing the concrete rings five sets of special steel forms were used, so that the operation, once under way, became practically continuous because as soon as the concrete in one set of forms had set sufficiently, the forms were removed and placed in position for the next ring. If the shaft had been concreted throughout its length, more than twice as much cement would have had to be used. The new shaft is not used for hoisting ore, but for transferring men and supplies. The No. 5 shaft, which is used exclusively for hoisting ore, is now to be deepened from the 2,500 to the 3,000 level.

C. & H. Coal-Pulverizing Plant, in Operation, Saves Much

At the smelting plant of Calumet & Hecla Consolidated, in the Michigan copper district, the new fuel-pulverizing plant is working efficiently, feeding all three of the large, 150-ton reverberatory furnaces. It will save 25 to 30 per cent in coal cost in the operation of these units.

As the second step in smelter improvements, the company plans the erection of a melting furnace of large capacity. This addition to the plant's melting facilities will release the three Jumbo type furnaces, which now are used both for melting and refining, for refining only. The proposed improvement will enable the plant to keep pace with production, even though it is increased with the development of a better market for the metal.

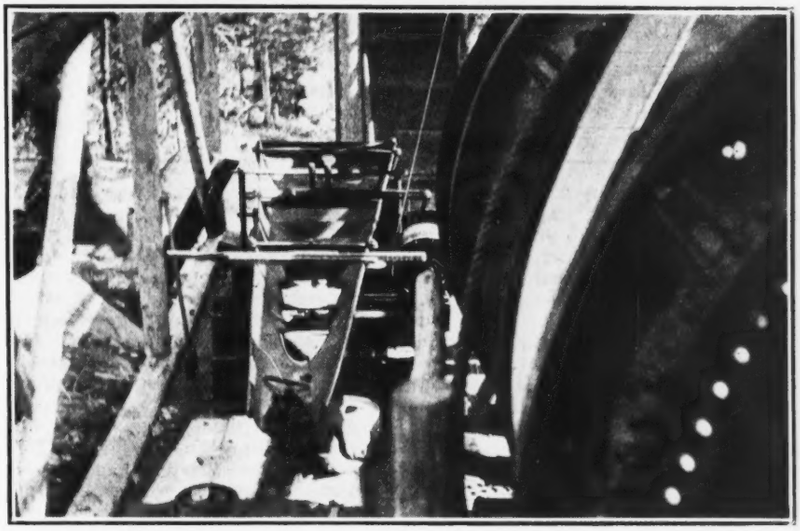
Red Mountain Hydraulic Mining Co. Completes Dam

Improves Water Supply for Montana Placers—LeRoy Amalgamators and Concentrators Used

THE Red Mountain Hydraulic Mining Co., which controls about 300 acres of placer ground four miles from Rimini, Mont., has just completed the new dam, which will hold water for 120 days' operation on a two-shift basis. The company is headed by E. A. Morley, with whom are associated Charles Hewitt and F. B. Winger. They have met the usual discouraging troubles that are encountered in similar undertakings, as well as many unusual ones, but have kept steadily at their work and now feel certain of profitable operation.

The known gold-bearing gravel extends along Try-Again Creek through the entire length of the property, an approximate distance of 10,000 ft. The width from rim to rim is about 600 ft. and has an average depth of 10 ft. The gravel washes easily and the bedrock is for the most part comparatively soft.

The gold is usually coarse and is distributed through the entire mass from grassroots to bedrock without much overburden. It is estimated that the entire deposit will average $1 per cubic yard. The black sands recovered, after going through the sluices, averaged $18 in gold per ton, and at many places where sampled a recovery of 50 lb. of black sands per cubic yard of gravel has been made.

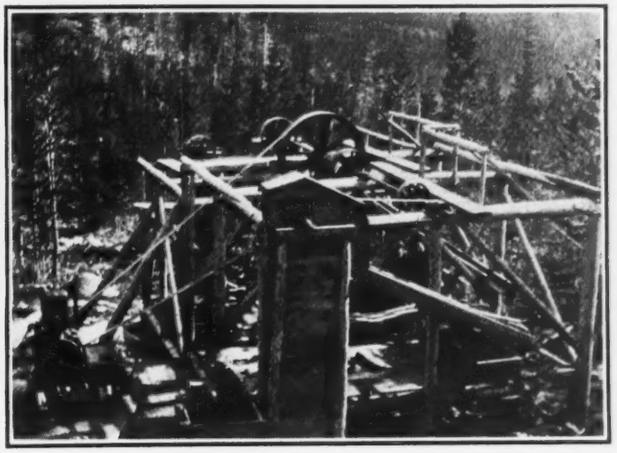


Ball mill and, at the left, a LeRoy concentrating and amalgamating table

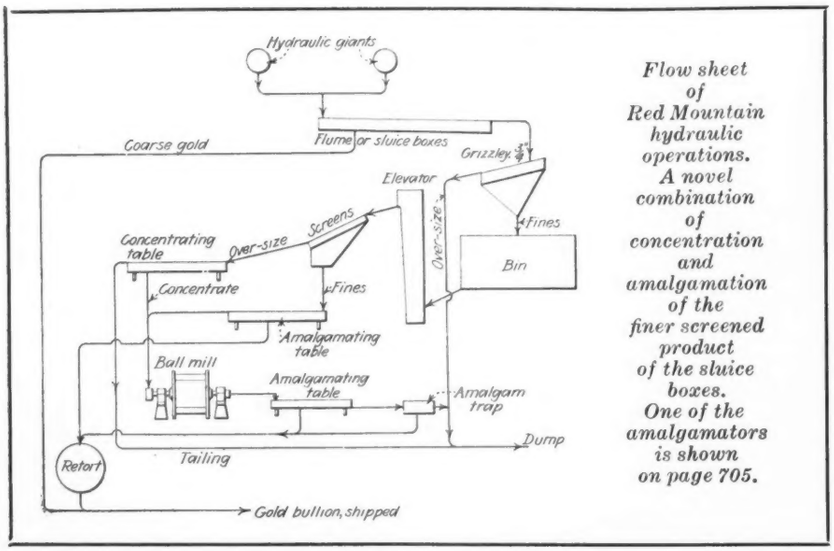
The water used in the hydraulic operation is obtained from a reservoir that is fed by springs and melting snow. This reservoir developed a bad leak, and a large quantity of this year's water was lost, so it was decided to construct the new dam below the old one. It is 125 ft. long and 22 ft. wide at bedrock. It will raise the water level 14 ft. above the top of the old reservoir, thereby increasing the capacity from 250 acre-feet to 375.

The last summer has been spent in

The pipe line supplies the hydraulic giants



Milling and concentrating plant at Rimini, Mont.



Flow sheet of Red Mountain hydraulic operations. A novel combination of concentration and amalgamation of the finer screened product of the sluice boxes. One of the amalgamators is shown on page 705.

rewashing and treating gravel that had been worked once. It was found necessary to do this so as to provide ample waste room for future operations. The property had been worked in such a manner that no provision had been made for the final disposition of washed gravel or waste. Furthermore, much gold in the gravel had not been recovered. A ditch was cut through a large reef of rock which formed a natural barrier for the old tailings. With the ditch completed, ample dumping space is provided for the life of the property.

A novel feature of the enterprise is the combination of milling methods used. Double-jointed, ball-bearing, king-bolt hydraulic giants operate under a 15-ft. head. These giants, supplied by the Hendy Iron Works, are equipped with 3-, 4- or 6-in. nozzles, as required. The gravel as loosened by the giants is carried to the sluices that are set at a grade of 7 in. to 12 ft. These sluices are equipped with the ordinary riffles and catch the coarse gold. The gravel as it leaves the flume is carried over a grizzly with ¾-in. openings, the fines going to a stock bin through the iron pipe shown in the illustration. As needed, the gravel is elevated to a set of screens; the fines therefrom go to a LeRoy concentrating and amalgamating table. This table is a shaped metal pan about the same length as the ordinary concentrating table, and has three or four amalgam traps in the bottom. A cam gives it a rocker motion. The accompanying photograph shows one to the left of the ball mill. The oversize goes to another similar table that is without the amalgamating feature.

Grinding is done in a special 5-ft. by 6-ft. ball mill using 3- and 5-in. steel balls as grinding media. A 60-mesh product from the ball mill goes to another LeRoy table and the reject therefrom goes through an amalgamating trap. The product from trap or table may be sent back to the ball mill for regrinding if desired.

Will Reopen Wedge Mine

Work is to be resumed at the Wedge property at Marysvale, Utah. This mine has produced gold-silver ore from limited workings. A new company has been formed, to be known as the Marysvale Gold Mining Co., with Newton Dunyon as president. The ore is high-grade, and it is thought that with more careful development the mine can be brought to further production.

Butte & Burlington Will Sink

The Butte & Burlington Mining Co. controls the Black Warrior, Montana, and Tiger claims, at Butte, Mont. Sinking will be started on the Montana as soon as an electric hoist is installed. It lies north of the once famous Blue Bird mine and west of the Nettie mine, the well-known silver producer owned and operated on a large scale by the Anaconda Copper Mining Co.

A. S. & R. Co. Increases Output at Durango, Colo.

The American Smelting & Refining Co. has increased the roasting capacity at its Durango smelting plant in Colorado, and is treating about 5,000 tons of concentrates and crude ore monthly.

The "sulphating plant" has been taken over by the company. In the past it has been operating exclusively on ore from the Black Bear and Sunnyside mines, at Telluride and Eureka. The process for the treatment of complex zinc ores seems to have been worked out to a commercial success, and the $400,000 plant will now be employed on custom ores.

Mason Valley Mines Co. May Resume Copper Production

The Mason Valley Mines Co., in Nevada, has completed its 900-ft. adit, and has started a 600-ft. shaft from this working. The deeper parts of the orebodies will be developed from this shaft, and connection will be made to the lower tunnel workings for convenience in mining.

A tramway is being constructed from the portal of the new adit to the Bluestone mill of the company, and ore will be transported over this tramway by trolley locomotives. The mill has a capacity of about 800 tons of ore per day, but it is reported that proposed additional machinery will increase its capacity to 1,000 tons daily.

If work contines as at present all surface equipment should be completed, and necessary preparatory mine work finished early in 1925, at which time production will likely be resumed in mine, mill and smelter.

Red Mountain hydraulic mine

A double-jointed, ball-bearing king-bolt giant is in operation

Anaconda Will Sink Pennsylvania Shaft from 2,900 to 3,600 Ft.

THE Anaconda Copper Mining Co., at Butte, has started sinking the Pennsylvania shaft from the 2,900 to the 3,600 level. This property employs about 700 men when in full operation and is one of Anaconda's largest mines. It has not been operated for almost a year.

Joplin-Miami Concentrate Shipments, 12,390 Tons; Price $43

Sales of zinc concentrate in the Joplin-Miami district for the week ended Oct. 18 totaled 12,390 tons, considerably below the production for the week. The base price was $43 at the end of the week, although buyers tried to hold the price at $42.50 for 60 per cent concentrate. The following table shows the active shippers:

	Zinc	Lead
Oklahoma		
Acme		47,980
Admiralty	1,147,200	.....
Aldridge	64,640	.....
Amalgamated	590,050	.....
Anna Beaver	881,600	182,870
Auburn	86,780	.....
Barnsdall	170,940	.....
Bilharz	509,780	.....
Blue Goose	592,860	61,850
Blue Streak	84,080	.....
Brewster	239,200	74,660
Commonwealth		58,090
Crystal	269,040	.....
Dobson	217,360	.....
Domado	434,450	.....
Dorothy Bill	1,617,440	74,110
Farmington	175,130	.....
Forth Worth	156,370	.....
Golden Rod	3,674,680	357,610
Gordon	367,170	121,230
Gordon-McBee		395,520
Grace B	88,150	.....
Hawkeye	97,630	.....
H. and T	296,590	.....
Hope	164,940	.....
Huttig	2,013,500	.....
Indiana	258,290	.....
Jaybird	577,640	252,580
Jeff City	153,850	.....
Kitty	253,970	.....
Laclede	86,960	.....
LaSalle	161,600	.....
Lenora	41,860	.....
Lion	81,920	.....
Lucky Bill		110,680
Lucky Kid No. 2	167,080	.....
Lucky Syndicate	264,360	930,340
Mahutska	86,540	.....
Manhattan	284,680	.....
Mary Ann	85,700	.....
New Chicago	174,150	.....
New York	193,710	79,970
Oko	117,500	.....
Pat	174,120	.....
Picher Mines	2,053,770	533,720
Plumb	97,250	.....
Premier	346,690	.....
Rialto	508,360	.....
Royal		100,430
Santa Fe	86,880	.....
Seammon-Hill		161,630
Skelton	1,995,350	.....
Smith-Davis	777,810	108,650
S. R. & W	170,290	.....
St. Louis	1,345,820	.....
Texas	347,040	.....
Tom L	118,090	.....
Underwriters	1,842,880	.....
Vantage	86,510	.....
West Virginia	170,040	.....
Whisk Broom	86,390	.....
White	1,466,550	117,020
Wilson	242,620	132,290
Sundries	.....	846,150
Total	28,484,650	3,542,950
Value	$586,770	$191,320
Kansas		
Barr	743,160	175,480
Baxter M. Co	66,850	.....
Bendelari	395,880	.....
Blue Diamond	62,120	84,990
Barnsdall No. 3	152,510	.....
Butte-Kansas	856,860	.....
Chanute	65,620	.....
Cherokee Dev. Co	65,890	.....
Cherokee L. & Z. Co	647,990	.....
Chubb	211,890	.....
Commonwealth	75,520	.....
Euterpe	439,960	.....
Federal-Jarrett	338,940	.....
Grace B. No. 2	190,180	.....
Homestake	130,020	.....
King Brad	441,380	.....
Lawyers	684,520	166,120
Muncie	87,380	90,910
Qualls	108,750	.....
Racetrack	163,270	.....
Redskin	344,320	.....
Southern	88,340	.....
Tar Creek	165,010	.....
Tulsa-Quapaw	236,560	.....
Underwriters		458,720
Wade	174,560	.....
Sundries	54,310	211,230
Total	6,512,670	1,187,450
Value	$137,270	$65,280
Missouri		
Barnsdall No. 2	151 660	.....
Freehold	150,490	.....
High Five	68,210	.....
Tulsa-Pittsburg	68,880	.....
Sundries	75,180	161,910
Total	800,490	161,910
Value	$17,160	$6,580

The following figures recapitulate: total shipments for the week—zinc, 35,797,810 lb.; lead 4,892,310 lb. Value, zinc, $741,200; lead, $263,180. Total value $1,004,380. Total shipments since Jan. 1—zinc, 1,146,321,500 lb.; lead 152,232,800 lb. Value, zinc, $23,669,630; lead, $7,609,050. Total value, $31,278,680.

Lead-Silver-Zinc Properties in Kootenays Attract Attention

Buoyant Metal Markets Are Incentive—Bluebell, Florence, and North Star Will Probably Be Reopened—First Two Have Mills

By F. H. Mason
Mining Engineer, Victoria, B. C.

THE steady demand for lead, silver, and zinc is attracting the attention of capitalists to the Kootenays, in British Columbia, and it is probable that several old mines in the region will be reopened. The Bluebell mine, at Riondel, on Kootenay Lake, is being unwatered preparatory to the renewal of operations. The Bluebell has been the principal producer in the Ainsworth district; it was located in the 90's and developed to a depth of 700 ft. on the west side of a vertical north and south fault, when a heavy flow of water was encountered with which the pumps were unable to cope. Attention was then turned to a considerable body of carbonate ore above the water level, and this was worked successfully until the spring of 1921, when low metal prices, high cost of operation, and the difficulty of finding a market caused a cessation of operations.

S. S. Fowler, who has managed the operations for many years, believes that the fault has caused a depression of the orebody, and that it will be found at a lower level on the east side of the fault. The swampy nature of the ground to the east of the fault has prevented surface prospecting. The flow of water coming from the mine is estimated at 200 gal. per minute, which can be taken care of easily with proper equipment. There is a mill and water-power plant on the property and an ample supply of water throughout the year.

Spokane interests have examined the Florence mine, at Ainsworth, with a view to its purchase. The Florence has been a good producer, but its operations seem to have been fraught with an unusual amount of hard luck. The mine paid a dividend of $34,746 in 1919, and then lost the whole of its production in an unfortunate lead "pool," which crippled the owner financially.

A plan for reconstructing the company, by which Detroit interests were to assume all debts, provide working capital, and obtain a controlling interest, was formulated more than a year ago, and a considerable amount of money was spent in new equipment, when the Detroit interests backed out. Since then some work has been done by lessees, and 62 tons of concentrate has been shipped since the beginning of this year. The mine contains both fissure and replacement veins, one of the latter being more than 60 ft. wide and carrying good milling ore, with high lead and low silver content. There is a 350-ton mill on the property, and arrangements were completed by the Detroit interests for power from the city of Nelson plant.

O. C. Thompson and associates are reported to have made arrangements for the reopening of the North Star mine, at Kimberley, and for the erection of a 100-ton mill. Some persons familiar with the district believe that the North Star carries the extension of the Sullivan ore deposits, but this is doubtful. Operations have been confined chiefly to shallow workings and in oxidized ore. Mr. Thompson and his brother had the mine under lease for three years, during which he shipped 16,000 tons of carbonate ore, but the slump of 1921 compelled him to discontinue operations. Complex ore similar to that found at the Sullivan has been uncovered, but as the property possesses no concentrator, it has not been worked.

Prospecting Near Stark City Shows Encouraging Results

After three months of prospecting on virgin acreage near Stark City, Mo., southeast of Joplin, the Hunter Mining Co. has purchased three additional drill rigs and is starting them at work with the purpose of thoroughly drilling encouraging prospects in this section of the zinc-lead field.

In four holes the Hunter company reports zinc ore in what is apparently a semi-hard ground formation, coming in at a depth of 178 ft. and extending to 208. The ore is high grade and free from iron, and assays have indicated as high as 10 per cent recovery.

The company has about 1,700 acres under lease near Stark City, and other companies are becoming interested. It is reported the Federal Mining & Smelting Co. has taken leases on the large acreage owned in fee south of Granby by the American Zinc, Lead & Smelting Co., and will likely extend its explorations as far as Stark City. W. H. Hunter, of Aurora, Mo., is president of the Hunter company.

Genuine Prospectors Have Good Opportunity in Alaska

Big Mineral Discovery Would Put Railroad on Profitable Basis—Too Much Boosting

Unless the Alaskan mining industry should develop at a rate faster than now is anticipated, the Government Railroad must continue to be operated at a deficit for many years. Regardless of any steps that may be taken to camouflage the fact, the line is now operated at a loss of $1,000,000 per year. In the opinion of practical observers, who do not believe any benefit follows unsubstantiated boosting, a gradual reduction of the deficit may be expected as tonnage gradually is built up. The only hope of the railroad is the development of the mining industry, although there will be important contributions of freight eventually from other sources. At the same time, it is admitted that a chance exists for the elimination of the deficit at a much earlier period were some unusual mineral discovery to be made. The development of another Kennecott, for instance, in itself would wipe out the deficit.

In the opinion of technical men who have been in Alaska this summer the territory has suffered very greatly because the American public has been given an inaccurate picture of Alaskan resources. Only a series of miracles would make possible development at the rate which frequently is forecast. There are evidences that those responsible for much of this over-advertising have reached the conclusion that it does not pay.

Alaska rapidly is becoming self-supporting in the matter of agricultural production. All the needs of the railroad now can be supplied from local coal mines, and the fuel requirements of the population now are being met largely with coal. The territory is not expected to become an exporter of coal.

The greatest single need of the territory is described as being real prospectors—not the "plaza" miner, but the type of prospector who will spend his time in the hills. There are fourteen great centers of mineralization in Alaska, no one of which has been prospected thoroughly.

At this time the railroad is benefiting materially from shipments of silver ore from the Mayo district. This ore is coming down the Stewart and Yukon rivers, and is transferred to the railroad at Nenana, which gives the railroad a haul of 412 miles. The development of silver properties is responding to the increased price of that metal.

Verde Jerome Will Deepen Shaft

Active development of the Verde Jerome property, in the Jerome district in Arizona, has been started, with W. B. Gohring in charge. The machinery and equipment which was used at the Jerome Del Monte has been purchased and overhauled and is to be installed immediately. The shaft, at present 150 ft. deep, has a good headframe. It is planned to sink to 1,000 ft. as rapidly as possible.

"Secondary" Metals Big Factor

PLANTS engaged in the smelting and refining of scrap metals had an aggregate output valued at $35,785,501 in 1923, according to figures just made public by the Bureau of the Census. This represents an increase of 136.2 per cent over similar returns in the 1921 Census of Manufactures. The 1923 production came from forty-one plants, a reduction from sixty plants in 1921.

Tonopah Companies Stipulate Sundry Operations, Pending Lawsuit

In the case of the Tonopah Extension Mining Co. vs. the West End Consolidated Mining Co., et al., in which the latter were charged with carrying on work under the surface boundaries of the Panther and New Jersey lode claims of the Tonopah Extension company, the hearing set for Oct. 17 has been advanced to Nov. 15. In the meantime a stipulation has been entered into which permits the plaintiff to survey and map the underground workings in the Tonopah "76" and Seventy Nine Fraction claims of the defendants. It permits the defendants to use certain workings under plaintiff's ground for transportation and passage, and also grants them the right to survey and examine certain workings driven by plaintiff into the Panther claim, about 300 ft. below the workings of the defendants. It is believed that these have cut the same vein as is being developed by the defendants on the upper levels.

In the meantime, development work is being carried on in both the Tonopah "76" and West End Extension territory, following the vein upward to the south in undisputed ground.

Lessees Reopen Oxford Mine at Downieville, Calif.

The Oxford mine, just north of Downieville, Calif., is under option by William R. Maloney, James O. Carlisle and Charles B. Brackin. The mine was opened about twenty years ago, and was taken over in 1915-17 by the Cliff Leasing Co., of Salt Lake City. It was shut down during the war. It is now being reopened by Brackin and his associates. The property consists of four claims, millsites, and timber lands. Two crosscut adits, the lower one 622 ft. long and the upper 650 ft., intersect a vein system consisting of three veins from 4 to 6 ft. wide. From the lower adit the largest vein has been drifted 800 ft. north and 100 ft. south. The adit will be driven 800 ft. further to intersect the downward extension of the ore shoot mined in the upper adit. The mineralized zone is near a slate-serpentine contact.

The present operators are planning to put in a ten-stamp mill and compressor. The Gold Bluff mine is northeast of the Oxford and the Triple Pocket mine southeast.

Gold Mining in Washington State Is Looking Better

Knob Hill Ships 175 Tons Weekly—First Thought, at Orient, May Have Cyanide Plant

Gold mining in the State of Washington has been on the upgrade for the last few months. In the Republic district the Knob Hill mine is shipping 175 tons of crude ore per week. The Northport Smelting & Refining Co., owning the Lone Pine and Surprise mines, is blocking out large reserves in the lower levels of the mines.

In the Orient district, in Stevens County, the First Thought mine has been reopened. The district has shown little sign of activity for several years. The First Thought is fully equipped with machinery and an aërial tramway three miles to the railroad. The property has produced 35,000 tons of ore averaging $16.88 per ton and has large reserves of lower-grade ore in the stopes. The mine was recently purchased from former owners by a Spokane syndicate headed by Otis J. Smith, who plans to erect a modern cyanide plant to work the low-grade ores which average between $5 and $10 per ton.

In connection with the low-grade ore occurrences, recent operations have disclosed better ore in the mine at widely separated places, running as high as $30 per ton, according to Mr. Smith. It is estimated the low-grade ore will total 400,000 tons.

Glen-Allen Will Resume Milling at Park City

At the Glen-Allen mine, at Park City, Utah, the shaft is being unwatered to the 200 level, and it is proposed to develop at greater depth the orebody exposed on the tunnel level. The ore has been found on two levels below the tunnel level, and drifting will be done along the vein on both. The tunnel level will be extended to cut the limestone-quartzite contact.

The mill is being put into condition for operation, which is expected to begin in ten days. The ore is silver-lead.

Transportation facilities have been much improved by the operation of the branch railroad extending to the Park-Utah mine at the mouth of the Ontario drain tunnel No. 2. As a result of the operation of this road the wagon haul for the Glen-Allen has been reduced from six miles to one and a half miles. Hauling costs have been reduced proportionally. J. F. Featherstone is manager.

North Butte Has Vein but No Ore at Superior, Ariz.

The North Butte Mining Co. is said to be cutting promising ground in its new property at Superior, Ariz. In the 701 drift at 600 ft. it has cut a strong vein, the strike of which is north 73 deg., and the dip 70 deg. east. This vein is 15 ft. wide but contains no ore where penetrated. Work will be continued by drifting east.

The management is encouraged. Chester Hoatson is in charge.

Washington News

By Paul Wooton
Special Correspondent

Government Agencies Compare Production Costs of Copper

Fail To Find Marked Advantage from "Cheap" Foreign Labor—Depreciation and Depletion Lower in U. S.

In view of the determination of Michigan legislators to push an amendment to the tariff act which would place copper on the dutiable list, all the government agencies interested in that metal have been getting together some of the facts which have a bearing on the general position of the copper-producing industry of the United States in relation to producers abroad. The general conclusion seems to be that few facts can be marshalled to support an appeal for a duty.

There has been some difference of opinion as to relative costs of production here and abroad, but such calculations as have been made indicate that foreign producers enjoy no material advantage in the matter of production costs, except where a big difference in tenor of ore exists. It is true that operating costs in the United States are higher than in foreign countries, but both depreciation costs and depletion costs are lower in the United States than they are abroad. These calculations do not take into consideration long-term bonds or capital invested.

The capital cost in the United States is less than 30c. per pound of annual production, whereas the entire foreign group shows a cost greater than 30c. per pound.

The deduction being made is that any economies which may be effected in foreign operations because of lower labor costs are offset by higher plant charges and the higher cost for the depletion of reserves. In addition to this, the interest on investment in foreign copper constitutes a higher charge before any dividends derived from profit might be declared. Though all the figures are not available, the assumption based on the reports of the largest producers is that costs of production here and abroad do not vary widely. Unless lower costs of production abroad can be established, an important argument for the imposition of a duty is lost.

Valuable Silver Deposits Reported to Have Been Opened in Norway

IT IS REPORTED from Christiania, Norway, by the Swiss Press Telegraph that extremely rich deposits of silver ore have been discovered in the district of Kongsberg. The director of the Kongsberg Mines states that the newly discovered deposits are extremely large and that silver mining in Kongsberg may become an important industry.

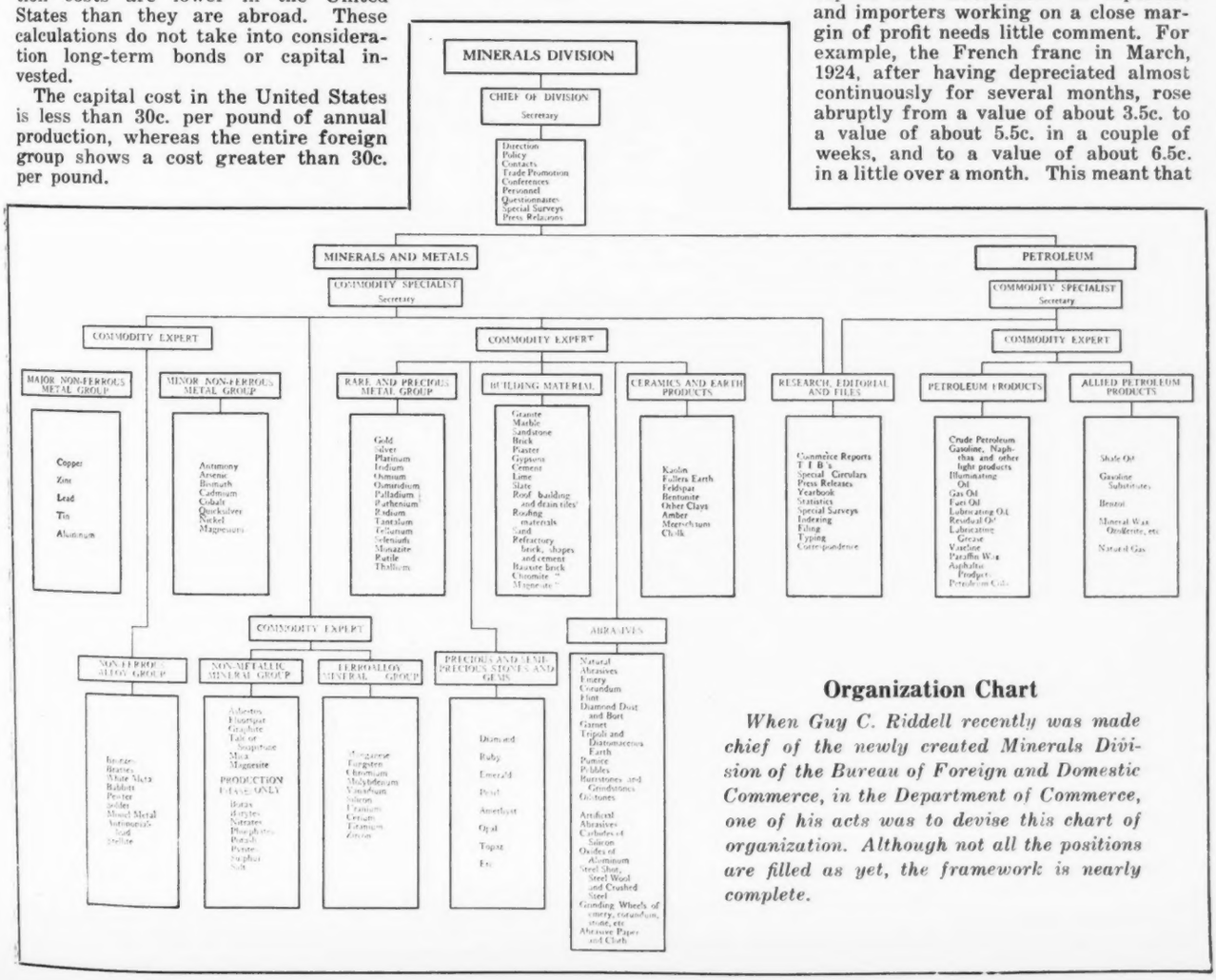
More Literature from Senate Gold-Silver Commission

Says Exchange Fluctuations Continue, but Situation Is Better in Some Countries

Five new publications are to be issued by the Senate Commission of Gold and Silver Inquiry. The first of the series, however, will be a revision of the commission's Serial No. 2, which contains daily exchange quotations and curves for eighteen countries, going back as far as Nov. 1, 1918. In the revision, these quotations will be brought up to Nov. 1, 1924. The four entirely new booklets will deal with analyses of various phases of the commission's exchange, currency, and trade investigations.

In the foreword of the revised publication, which is to be ready before Congress convenes, the following statements occur:

"European currencies are in much better shape than they were a year or two years ago and are continuing to improve. Few countries, however, have worked out reforms of a permanent nature, and the general restoration of gold as the international money of account is still in the future. Until such reform is consummated and currency units are tied together by a common metal, gold, relatively wide exchange fluctuations will continue. The handicap of such fluctuations to exporters and importers working on a close margin of profit needs little comment. For example, the French franc in March, 1924, after having depreciated almost continuously for several months, rose abruptly from a value of about 3.5c. to a value of about 5.5c. in a couple of weeks, and to a value of about 6.5c. in a little over a month. This meant that



Organization Chart

When Guy C. Riddell recently was made chief of the newly created Minerals Division of the Bureau of Foreign and Domestic Commerce, in the Department of Commerce, one of his acts was to devise this chart of organization. Although not all the positions are filled as yet, the framework is nearly complete.

Pioneer Prospector of Ray Mines Leaves $250,000

THE late William Soufrien, of Ray, Ariz., pioneer prospector of the claims later developed by the Ray Consolidated Copper Co., left an estate estimated at approximately $250,000, practically all in cash. It is believed that the inheritance tax will amount to about $30,000, probably the largest ever yielded in Arizona by an estate of that size, owing to the fact that practically all beneficiaries are non-residents.

an exporter holding a draft for 100,000 francs would have received about $3,500 if he had sold the draft in the first week of March, while its retention for ten days longer would have netted him $5,500. Had he retained it a month he would have received $6,500.

"Exchange fluctuations in most European countries have been less violent in recent months. In some countries considerable stability has been exhibited. The period of extravagant finance which prevailed in Europe for several years has about run its course. Signs of more settled and stable conditions are appearing."

Julieta Gold Mines Equips Plant in Chihuahua

The Julieta Gold Mines, Ltd., has installed equipment for conducting the Thayer electrochemical - centrifugal process for recovering gold at its property in Chihuahua, Mexico. The machine consists of two cylinders, one within the other, with a clearance of ½ in. They are electrically insulated from each other, but revolve together at a speed of 350 r.p.m. As the machine revolves mercury forms a floating cathode on the interior of the outer cylinder. The claim is made that the combined electrolytic and centrifugal phenomena recover very effectively gold in the pulp passing through the machine. The revolving must be stopped at intervals to clean up the amalgam.

Burma Corporation Mined 700 Tons Daily During September

The Burma Corporation during September mined 20,669 tons of ore from the Baldwin mines, in Upper Burma, A total of 21,200 tons of ore was milled, producing 10,230 tons of lead concentrate; 12,976 tons of lead-bearing material was smelted in the blast furnaces, producing 5,279 tons of hard lead for treatment in the refinery. Refinery products were 4,301 tons of refined lead and 441,000 oz. of refined silver. Of the silver produced, 21,600 oz. were recovered from the treatment of copper matte. The experimental zinc plant produced 1,738 tons of zinc concentrate, assaying 10.64 oz. of silver, 8.52 per cent of lead, and 44.87 per cent of zinc. In addition, 300 tons of copper matte was produced from the treatment of 1,184 tons of copper ore and accumulated smelter byproducts, as well as 200 tons of antimonial lead.

London Letter

By W. A. Doman
Special Correspondent

Good Silver Market Stimulates Interest in Various Mining Shares

Barrier Range and Burma Corporation Feels Effects—Continental Countries Buy for Coinage

London, Oct. 14—Last Thursday silver touched the relatively high price of 36 1/16d. per ounce. It has since dropped to 35⅞d. It appears that various governments in Europe are buying for coinage purposes. Naturally, the demand for the metal has stimulated interest in shares of silver-producing companies, principally those on the Barrier Range, N. S. W., and also of the Burma Corporation. San Francisco Mines of Mexico have also been favorably affected. China has been a buyer of silver, and it is said that the rise in the price is to some extent due to bear covering.

It seems scarcely credible that, if the East Rand Proprietary Mines is no more than a shell, there should be such a struggle for control. In South Africa, where presumably those interested are more promptly in possession of information as to conditions, a shareholders' Protection Committee has been formed. The secretaries of the company are the Rand Mines, Ltd., and the manager of Rand Mines has come to London. He has offered to call on the largest shareholders here, while he is inviting shareholders generally by means of a circular to consult him if they desire information. It is a rather unusual step for a great financial house to take, and I can remember only one previous case where Kaffir mining companies are concerned. There is revenue to be earned in managing a big mine, and presumably the Rand Mines does not wish to lose this source of income, besides which its policy has not previously been questioned. Unlike the Central Mining & Investment Corporation, it does not invest its capital in different parts of the world.

Several months ago it was stated that Government Areas (Far East Rand) was worth £8 per share and that the shares were going there to be split. They have never yet touched that figure, but recently a rise has taken place. and the goal seems well within realization. This may be due to the fact that the management has decided to increase the monthly capacity of the plant from 160,000 tons to 200,000 tons. It is not expected, however, that this new equipment will be fully installed and in operation before the beginning of 1926. The construction will be financed out of the company's present resources and the monthly profits to be made in the meantime. As ore reserves aggregate 11,000,000 tons, there is no need to spend much money on development unless the management consider it advisable to keep about five years ahead of full mill requirements.

A Labor member of Parliament has declared that £1,000,000 is needed to put Cornish tin mining on its feet. He specifies no suitable source for getting the money.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Wright-Hargreaves Improves Mill Heads and Earnings

Six Months' Production Totaled $440,000—Good Ore on 1,600 Level —Mill Capacity Increased

Toronto, Oct. 25—During the first six months of the present year the Wright-Hargreaves mine, in Kirkland, produced $444,000 from ore averaging $10.81 per ton; this production will be considerably exceeded during the latter half of the year, as a result of higher mill heads; and these higher mill heads are due to rich ore being mined in the new vein being opened up on the 1,000 level. To date the drift has been run over 400 ft., and the average assay is much higher than the average of the rest of the mine. Good progress is being made with the additions to the mill, and it is expected that in the early part of 1925 the capacity will be raised to 400 tons a day.

On the Sylvanite property, which adjoins the Wright-Hargreaves and is controlled by the same interests, new veins have been found on the crosscuts from the 1,000 level. Development at this depth is giving promising results, and it will probably not be long before the company considers a mill.

During the first half of the present month production at the Teck-Hughes amounted to $39,400, which is an increase of about 10 per cent over the preceding month.

At the Horne property of the Noranda Mines, Ltd., in northwestern Quebec, No. 1 shaft has been completed to the 110 level and crosscutting is progressing at 100 ft. So far results are corroborating the returns of the diamond drilling. Two diamond drills are still at work, and the dimensions of the ore zone are continually being extended.

The Laurentide Air Service announces that, owing to its failure to secure a subsidy from either the Quebec or the Dominion government, it will not institute a winter air service into Rouyn. Up till the end of August the company had transported 500 passengers and 35 tons of freight, in addition to mail, telegrams, and miscellaneous express parcels. A total of 119 trips were completed in 120 days. The operators in the Rouyn district found the air service to be valuable, as it enabled men to go from Haileybury to the district in about two hours, instead of two days by the land and water route. Unless monetary assistance is extended, the service will be discontinued for the present season, at the close of navigation. During the winter freight will probably be transported from the end of the new Kirkland branch railroad which will soon be completed as far as Larder Lake.

The Associated Goldfields, at Larder Lake, has started the construction of a 600-ton mill. The mill buildings should be completed in November and the machinery will be installed during the winter. A new hoist capable of hoisting from a depth of 4,000 ft. will soon be purchased.

Men You Should Know About

Seeley W. Mudd, mining engineer, recently paid a visit to San Francisco.

Donald H. Fairchild, of Chicago, has been in New York and at Wilkes-Barre, Pa.

Roy A. Sulliger, mining engineer, is at Berkeley, Calif., on vacation from Sonora, Mexico.

F. J. Mitchell-Roberts, metallurgical engineer, left San Francisco on Oct. 26 for New York and London.

F. C. Ninnis, mill superintendent for the West End Consolidated Mining Co., at Tonopah, is in San Francisco.

J. B. Joel, head of Barnato Brothers of London, is on his way to visit the mining camps of northern Ontario.

Louis D. Huntoon, consulting engineer, has returned to New York from a month's examination trip in Canada.

E. A. Julian, general manger for the Goldfield Consolidated Mines Co., has been in Goldfield from San Francisco.

H. Foster Bain, director of the U. S. Bureau of Mines, was recently in Reno on a visit to the Reno station of the Bureau.

Professor C. E. Locke, of the Massachusetts Institute of Technology, is making an extended visit to Colorado and Arizona.

Reginald McLean has been promoted to the position of general mine foreman of the United Verde Extension Mining Co., at Jerome.

W. Pellew-Harvey, mining engineer, has left England for South Africa, to make an examination of the Eileen Alannah mine.

M. J. Elsing, of Warren, Ariz., has taken an option on the Old Glory group of mining claims, near Ruby, Ariz., from B. H. Worthington.

Frank M. Estes, manager of the Dolores Mines Co., Madera, Chihuahua, Mexico, was in New York during the latter part of October.

G. D. Van Arsdale, consulting metallurgist, has returned to his headquarters in Los Angeles after a professional visit to Douglas, Ariz.

Eugene H. Dawson, consulting mining engineer of New York, has returned from British Columbia following an extended professional trip.

Clyde A. Heller, president of the Tonopah Belmont Development Co., has gone to the Surf Inlet mine of the company after several days at its Tonopah property.

Cleveland H. Dodge, vice-president of the Phelps Dodge Corporation, has been visiting the properties of the corporation in Arizona, New Mexico, and northern Sonora.

Harry Kee, formerly manager of the Goldale and the Kerr Lake mines, has been engaged by the McIntyre-Porcupine to sink the new central shaft to a depth of 4,000 feet.

Dr. J. F. Wright, of the Canadian Geological Survey, has completed for the season his investigation of the gold and copper area northeast of Winnipeg, and returned to Ottawa.

Professor J. G. Lawn, of University College, Johannesburg, South Africa, has resigned his position as joint managing director of the Johannesburg Consolidated Investment Co.

Dr. W. H. Weed, of the Weed-Sturgis Syndicate of New York, has completed a thorough examination of the Rouyn Gold Mines property, recently taken over by the syndicate.

Dr. Alfred W. G. Wilson, of the Canadian Department of Mines, has returned from an extended visit to England, where he was engaged in the dissemination of information regarding Canadian mining.

Charles F. Williams

Charles F. Williams, recently with the American Smelting & Refining Co. in Mexico, has accepted the position of Deputy Mining Supervisor for the Bureau of Mines in the Tri-State zinc and lead district. His headquarters are at Miami, Okla.

C. T. Young, of the Resources and Development Department of the Canadian National Railways, has returned to Montreal after a tour of inspection through the northwestern Quebec gold fields.

A. Shaw McKean has been elected a director of Calumet & Hecla Consolidated Copper Co., succeeding **Thomas Nelson Perkins,** who has been appointed American member of the Reparations Commission.

Arthur C. Brinker, engineer, of New York, formerly connected with the Camp Bird mine, in Colorado, has been making examinations of the East Leadville Co. property, at Leadville, Colo., for New York interests.

R. L. Chase, mining and geological engineer, of Denver, has spent the last two weeks in New York City. From New York he will go to the San Juan district, in Colorado, and then to Chihuahua, Mexico, on mine examination work.

H. Mortimer Lamb, secretary of the British Columbia division of the Canadian Institute of Mining and Metallurgy, spent several days in Berkeley, Calif., after attending the American Mining Congress convention at Sacramento.

Edwin T. Hodge, professor of economic geology, University of Oregon, spent the summer making a study of the Cascade Mountains in the vicinity of the McKenzie Pass and the Oak Ridge Pass with reference to water supply and power for towns of the Willamette Valley.

A. W. Newberry, mining engineer, gave an illustrated talk before the members of the Mining & Metallurgical Society of America at the Harvard Club, New York, on Oct. 22, showing slides of photographs taken on his recent trip around the world, including pictures of mining operations in Africa and Australia.

William Selby has been awarded the Consolidated Mining & Smelting Co.'s scholarship of four years' tuition and $500 per year. The scholarship is open to the company's employees or their children. Mr. Selby completed his high-school course at Cranbrook last year, and since has been employed at the Sullivan mine. He will enter the University of British Columbia.

In *Mining Journal-Press* of Aug. 30, our biographical sketch of **Mr. F. W. Maclennan,** general manager of the Miami Copper Co., unfortunately placed his age in the early fifties, instead of the later forties. Properly enough, Mr. Maclennan, in most friendly fashion, directs our attention to this journalistic misstep. He is still, in a manner of speaking, within the charmed circle that has not passed the half-century mark. We are glad that the opportunity has been afforded to us to make correction and acknowledgment of error, for reasons that do not require elaboration of explanation to those either under or over the critical age. May Mr. Maclennan live to be a hundred!

Obituary

James H. Fahy, a prominent prospector and mining man of Red River, N. M., was instantly killed on Oct. 4, when his auto, which he was himself driving, left the road between Questa and Red River City and rolled over several times, pinning Mr. Fahy beneath it. Mr. Fahy was believed by his associates to have been the original locator of molybdenum in America. He was the discoverer of the molybdenum deposits at Red River, which he sold to the Molybdenum Corporation of America. He subsequently located another molybdenum deposit and organized the Mammoth Molybdenum Corporation, of which he was manager at the time of his death. He had lived in the Red River country for about ten years and was an insatiable and indefatigable prospector, typical of the West, in which part of the United States he was widely known and held in high regard. Mr. Fahy was born in New York City sixty years ago. Burial was in Red River.

Charles Fergie, of Montreal, who from 1901 to 1905 was president of the Canadian Mining Institute, and previously of the Nova Scotia Mining Society, died on Oct. 19. He was a member, also, of the North of England Mining and Mechanical Institute.

Societies, Addresses, and Reports

Northwest Mining Convention Plans Laid

Big Mineral Display Will Be Drawing Card—Night Sessions for Business and Educational Features—Committees Named

Plans are being made for the 1924 Northwest Mining Convention to be held in Spokane, Wash. It has been announced from the convention headquarters in the office of the Northwest Mining Association, 511 Chamber of Commerce Building, Spokane, that the date has been definitely set for Dec. 1 to 6. Secretary F. C. Bailey has once again undertaken to raise the money that is necessary to see the project through.

It is planned to have as big a mineral exhibit this year as possible, and make a special effort to get mining investors from all parts of the country on hand to see the show. It has been noted at previous conventions that attention has always centered on this particular feature. Although the matter has not been definitely decided, it is planned tentatively to leave the daylight hours free for visitors and local mining fans to discuss the mineral display, and to fill each evening up with addresses, lectures, discussions, and motion pictures dealing with various phases of mining.

Prospectors and mine owners in all parts of the Northwest have been requested to prepare their samples early and to ship them to Mr. Bailey. Exhibits of ore from many of the larger mines are on hand and available, having been held over from previous convention exhibits.

The various committees named are as follows, the first named being chairman in each instance: Executive, Ed. Pohlman, A. L. Hooper and A. A. Klockmann; Entertainment, C. A. Gray, Fred Howe and Thomas Murray; Reception, Ralston McCaig, Frank D. Allen, A. A. Booth, M. J. Sweeney and William Beaundry; Exhibits, Charles H. Goodsell, A. W. Patterson, and O. Jeldness; Information, Richard Marsh and Hilliard W. Power; Publicity, Storey Buck, Frank A. Ross, and C. N. Anderson; Program, Hilliard W. Power, Ralph E. Perry, and M. Baumgartner; and Finance, W. J. Kirby, F. C. Bailey, and S. H. Richardson.

Gemmell Memorial Clubhouse Opened at Bingham

The formal opening of the Robert C. Gemmell Memorial Clubhouse at Bingham, Utah, built by the Utah Copper Co. for the convenience of its employees, was marked by dedicatory exercises in honor of Mr. Gemmell, held on the evening of Oct. 6 in the building itself. Louis S. Cates, vice-president and general manager of the company, called the meeting to order. Presentation of a bust of Mr. Gemmell, by C. E. Dalin, a Utah sculptor, was made by Mrs. Gemmell, who had come to Utah for the exercises. Addresses honoring Mr. Gemmell were made by R. C. Lucas and by the Rev. P. A. Simpkin. Mr. Gemmell's valuable services in helping to build up the great low-grade copper producer, and his integrity and uprightness as a man were especially emphasized.

The clubhouse is a fitting memorial to Mr. Gemmell's work. Designed in mission style, it combines beauty, comfort, and utility. It has many facilities for amusement and relaxation, including gymnasium, shower baths, library, lounge rooms, and dance hall.

West Meets East at Zinc Institute's Mid-year Gathering

Discuss Advertising Campaign to Stimulate Consumption of Zinc—See "Follies" Afterwards

The directors and a fair representation of the membership of the American Zinc Institute convened at the new Roosevelt Hotel, Madison Ave. and 46th St., New York City, on Friday, Oct. 17, when several problems of general interest to the zinc industry received unusually frank discussion. In the morning, the members' conference was held. This was followed in the afternoon by a meeting of the directors, and in the evening by a dinner and a box party at the New Amsterdam to see the Ziegfeld "Follies."

The chief matter for discussion was the advertising campaign of the Institute to stimulate the consumption of zinc. Nearly $50,000 has already been raised. It was suggested that the money be pooled with a sum to be contributed by the galvanizing interests, but this plan was rejected, as it was felt that pure zinc products should get a fair share of the appropriation and that it would not be wise to make the fund a common one. Some objection was also offered to stimulating the use of zinc, on the ground that the ore reserves were limited and that it was not to the smelters' interest to work them out within ten years or so and then be obliged to scrap all the smelting equipment. Although the reserves of the Tri-state District are not known, it was thought by many of those present that no fears need be entertained respecting their early exhaustion. The matter of an insufficient coating of zinc on galvanized articles was brought up. This seems to be on the road to improvement through the manufacture of branded goods. One member suggested that the poisonous qualities of zinc when improperly used for household purposes should be investigated.

Many of the most influential men of the zinc industry in both the East and West were present at the directors' meeting in the afternoon, which, like the morning meeting, was presided over by A. E. Bendelari, president. It has been felt for some time that the Western members of the Institute were putting all of their surplus funds into the advertising campaign and leaving the Eastern members to finance the Institute proper. This and other questions were satisfactorily adjusted.

Seeking Non-Tarnishable Alloy of Silver

No Results Yet from Research Conducted by Government Bureaus to Develop New Uses for Metal

The investigation of new uses of silver being made by the Bureau of Mines and the Bureau of Standards is being pursued actively. Though nothing has been developed which points to a more promising field for the increased use of silver than popularizing the purchase of sterling ware, experiments are being conducted on the developments of alloys which with a comparatively small amount of silver may offer at a low price a relatively non-tarnishable alloy which could be used on automobiles and for other trimming.

In connection with extending the use of solid silver for household articles—and the possibilities in this field are very great, since 85 per cent of the silverware sold in the United States is plated—the first problem is to prevent tarnish. Investigation is being made of an alloy of silver and magnesium, an alloy of silver and tellurium, plus enough zinc or cadmium to soften the silver, and an alloy with a non-tarnishing metal, like chromium, in such a way as to coat the silver lattice with the alloy and protect it from sulphidization.

Better Management Discussed in Many Meetings

Management meetings were held during the period from Oct. 20 to 25, in many of the foremost industrial cities of the United States and Canada. The attention of leading engineers, educators, business men, and economists was concentrated for five days on management problems, particularly as they apply to the local communities where the meetings were held. Budgeting for better management formed one of the chief topics for discussion at these meetings.

The proceedings were under the direction of five national societies, namely, the American Society of Mechanical Engineers, the American Management Association, the National Association of Cost Accountants, the Taylor Society, and the Society of Industrial Engineers, with the co-operation of Chambers of Commerce, Rotary, Lions and Kiwanis Clubs and other civic organizations.

Pacific Petroleum Geologists Organized

Reports from Los Angeles quoted in the American Petroleum Institute's digest of petroleum news state that the Pacific Society of Petroleum Geologists was organized on Sept. 27, the second and last day of the first annual convention of California geologists. S. H. Gester, of San Francisco, geologist of the Standard Oil Co. of California, was elected chairman of the state organization, and Dr. R. R. Morse, professor of geology at the University of California, Berkeley, was named the secretary. Mr. Gester was empowered to appoint an executive committee of three members.

Recent Technical Publications

Reviews, Abstracts, and References

"The World-Struggle for Oil" Worth Reading

The World-Struggle for Oil. By Pierre L'Espagnol de la Tramerye. Translated from the French by C. Leonard Leese. Alfred A. Knopf, New York, publisher. Price $2.75.

This is a remarkable book which is worthy of a wide reading. Those who have been interested in the politics and economics of oil should not miss reading it. It is by a close French student of the problem; and he handles it without gloves. He treats the subject from the French point of view, just as Northrup's article on petroleum in "Political and Commercial Geology[1]" treated the same most weighty problem from the point of view of the United States.

Those who have been lulled to sleep by the false assurance that there was no national rivalry for oil should read this clear-cut story of the titanic conflict for the possession of the world's petroleum reserve, by immense commercial combines, allied with the greatest of the world's political and military powers. The first part of the book (three chapters) develops the axiom that "who has oil has Empire"; the second (three chapters) details the struggle between the Standard Oil Co. and Royal Dutch-Shell; the third part (ten chapters) the struggle between the powers; and the fourth part (six chapters) France's part in the struggle between Great Britain and the United States. Allowing for the usual mortal tendency to error, the reviewer feels that the book is a reliable, even if startling, history. It describes conditions that from time to time have been repeatedly and explicitly described in the editorial columns of *Engineering and Mining Journal-Press*, and which have not ceased to be important and compelling. Readers will perceive that, great as has been the influence of oil in domestic politics, as has been demonstrated during the last two years, this is insignificant compared with the major rôle it has played in shaping world affairs. The conclusion of the book, a survey of "The World in 1923," is a mournful summary of the position of France:

"The political independence of a people may sometimes be nothing but a sham. France, having neglected to obtain her share in the division of the world's oil, is today in a position of dependence upon Britain and America. If, tomorrow, she had to defend herself against a fresh attack, her tanks, her aëroplanes, her submarines, and the whole of her supply services could only function by consent of her Allies. Even with the first army in the world, France could be victorious only if Britain and the United States permitted."

The Great War, as the volume points out, was won by oil. "That the Allies have won this war is in great part due to the two greatest trusts, the Standard Oil and the Royal Dutch-Shell, which placed themselves at the service of the Entente. Germany, hemmed in on all sides, saw her last resources disappear when the Eastern front broke up. Without petrol for lorries, tractors, motor cars, aëroplanes—without heavy oil for ships' boilers and factory engines—without lubricating oil for all machinery, how was it possible to carry out the combined movements of armies? It was not until about 1916 that people began to say this war would be a 'war of oil.'"

And the final outcome of the war is thus commented on:

"'Thanks to the Inter-Allied Petroleum Conference,' as M. Henry Bérenger remarked, 'never at any moment have our soldiers lacked a drop of this spirit which gives them the necessary means of rapid movement and of cornering and defeating the enemy. If hostilities lasted only a few days more, our victorious troops would have taken, in the Ardennes, whole armies whose line of retreat was becoming so congested that they must have fallen into our hands without resistance. Hence the Germans hastily accepted the conditions which were imposed upon them, without either hesitation or discussion. (Dec. 7, 1918.)'

"This time the military and political importance of oil was apparent to everyone. On the morrow of the armistice (Nov. 11, 1918), it was celebrated in enthusiastic speeches. And Lord Curzon was able to declare, at Lancaster House, 'Truly, posterity will say that the Allies floated to victory on a wave of oil.'"

But with the termination of the war the struggle for oil mastery broke out afresh and at once. "*The struggle for oil*" states the author, in italics, as his closing word, "*is no longer a rivalry between great trusts; it is a struggle between nations.*"

J. E. SPURR.

The Gasoline Automobile. By George W. Hobbs, Ben G. Elliott, and Earl L. Consoliver. Third edition. McGraw-Hill Book Co., New York. Price $3.

Possibly no piece of machinery that is so generally used is so little understood as the automobile. It must of course have gasoline, and usually water; beyond this most owners think that plentiful lubrication is about all that is necessary, together with a general overhauling every year or so at the garage. It is to obviate this last and expensive proceeding, as well as to increase the comfort and economy of operation, that such books as this are written. There are chapters, well illustrated, on the types of engines, fuels, and carburetting systems, lubrication and cooling, the ignition, starting and lighting systems, and the chassis and running gear, the volume concluding with two chapters on automobile troubles and their remedies, and operation and care. The treatment is descriptive rather than critical.

[1]McGraw-Hill Book Co., 1920, J. E. Spurr, Editor.

Patents

Chloridizing Roasting—No. 1,507,858. W. A. Schmidt, Los Angeles, and G. M. Colvocoresses, Humboldt, Ariz., assignors to Western Metallurgical Co., Humboldt, Ariz. Ore is preheated by contact with hot gases, to about 800 deg. C., and then salt added. Further heat volatilizes metallic chlorides which pass to a fume-collecting device.

Sintering—No. 1,508,101. Sept. 9, 1924. Anders Holmberg, Stockholm, Sweden, assignor to Allmanna Ingeniorsbyran H. G. Torulf, Stockholm, Sweden. Sintering pans are charged with layers of ore containing different percentages of fuel in such a manner that the fuel gradually decreases from the top to the bottom of the charge. The charge is ignited and sintered by combustion induced by a downward current of air.

Ore-bin Gate—No. 1,508,560. Sept. 16, 1924. J. H. Ledeboer, The Hague, Netherlands, assignor to Freyn, Brassert & Co., Chicago. A combination of ore bin, discharge gate, and scale car, adapted for the automatic opening of the gate by a piston mounted on the car.

Arsenic Recovery — No. 1,509,688. Sept. 23, 1924. C. L. Parsons, Hawkinsville, Ga., and H. P. Bassett, Philadelphia, Pa.; Bassett assignor to Parsons. Arsenical metallurgical dusts are leached with hot water to remove water-soluble compounds, and the residue extracted with a hot alkali solution in sufficient amount and strength to give a di-alkali metal compound with the oxides of arsenic present in the residue.

Petroleum—No. 1,509,820. Sept. 30, 1924. W. E. Adams, and C. B. Hall, Tulsa, Okla. An apparatus for separating the gas, oil, and water from oil wells.

No. 1,510,669. Oct. 7, 1924. A. L. Halliday, Oil Center, Calif. A perforation cleaner for oil-well casings.

No. 1,510,871. Oct. 7, 1924. G. S. Swaim, Long Beach, Calif. A rotary-drill bit.

No. 1.511,067. Oct. 7, 1924. W. L. Russell, New Haven, Conn. A process of extracting residual oil from oil-bearing strata by the use of a liquid under pressure, containing gas, the oil attaching itself to the gas bubbles as the pressure is released underground.

Pulp Filtration—No. 1,511,785. Oct. 14, 1924. U. C. Tainton, Johannesburg, Transvaal, South Africa. When sulphuric acid is used to leach an ore, colloidal suspensions are sometimes formed which make filtration difficult. Conditions can be improved, according to this patent, by the addition of a fluorine compound adapted to be decomposed by the sulphuric acid.

Flotation — No. 1,512,139. Oct. 21, 1924. R. E. Sayre, New Rochelle, N. Y. The patent covers the use, as a flotation agent, of a heavy-metal xanthate in a non-acid pulp.

Ore Reduction—No. 1,512,262. Oct. 21, 1924. John Allingham, Los Angeles. A body of ore is subjected to a flame produced by liquid fuel and air containing an excess of oxygen, the proportions being such that the oxygen is substantially entirely consumed.

New Machinery and Inventions

Wolman Salts for Protecting Timber Against Decay and Spread of Fire

A Preservative That Is Said to Have Given Superior Results Abroad Now Being Introduced Into American Mine Practice

By John G. Kreer
Chemist and Engineer

MINING COMPANIES in Germany get from twelve to twenty years of life from mine props, as against a three-year average life in American mines, and they have practically eliminated the fire risk in metal mines by the treatment of mine timbers with what are known as Wolman salts, named after Karl Heinrich Wolman, a chemist and engineer of Berlin. These salts came into commercial use in Central Europe between 1902 and 1908, during a period when creosote was at the lowest price in the history of wood preservatives. After their first introduction they rapidly displaced all other preservatives for mine timbers, including creosote, zinc chloride, and sodium fluoride. Of the many suggestions of all sorts that have cropped up in the last twenty years, this is said to be the one process that has made a commercial success. This success has been continuous and has been extended year by year.

War conditions and post-war finances delayed the introduction of these salts into American practice until the beginning of this year. Though little material has been treated in the United States to date, an extensive use of Wolman salts is already indicated.

The subject may be summarized simply: The salts, consisting essentially of fluoride and dinitrophenols or cresols, are admittedly of great toxicity, many times that of any salt treatment heretofore known, and quite equal to the toxicity of creosote. These water-borne solutions are much more easily absorbed and diffused throughout cellular structure of sap wood than are oil-borne toxins; the mordants contained in the Wolman salt mixtures bring about a fixation in the fibres similar to that of mordants in the preparation of fast dyes, so that there is no leaching out of these salts. They are themselves just soluble enough to make up hot solutions for treatment, but are non-hygroscopic and non-deliquescent, and cause a cementation of fibre in wood that actually demonstrates increased tensile and compressive strength after treatment.

The intensely toxic and preservative characteristics of sodium floride and dinitrophenols and cresols are so well known that all technicians admit their value; and that there is no reaction to iron or to any form of paint is a matter of easy confirmation in the laboratory. That the salts do not leach out is shown by ties recently taken up after ten years' service under the most extreme conditions for producing both leaching and infection, which nevertheless showed an almost undisturbed salt content and a perfect condition of the wood.

In exceptionally bad spots in mines that were selected as such, props that had been treated with the salts and that had been in use for from ten to fifteen years have shown upon examination their protective salt content still present, and the wood fibres in perfect condition.

That dinitrophenols and dinitrocresols are of themselves inhibitively toxic in solutions as low as one part in 10,000, is well established, and the toxic properties of sodium fluoride are equally well known. It may, however, be worth mentioning that while sodium fluoride in, say, a 0.6 per cent solution is inhibitive to merulius, polyporus, and coniophora, it is by no means so effective against penicilium, and still less so for the lenzitis group; whereas phenols and cresols in minute quantities are a complete protection against the latter.

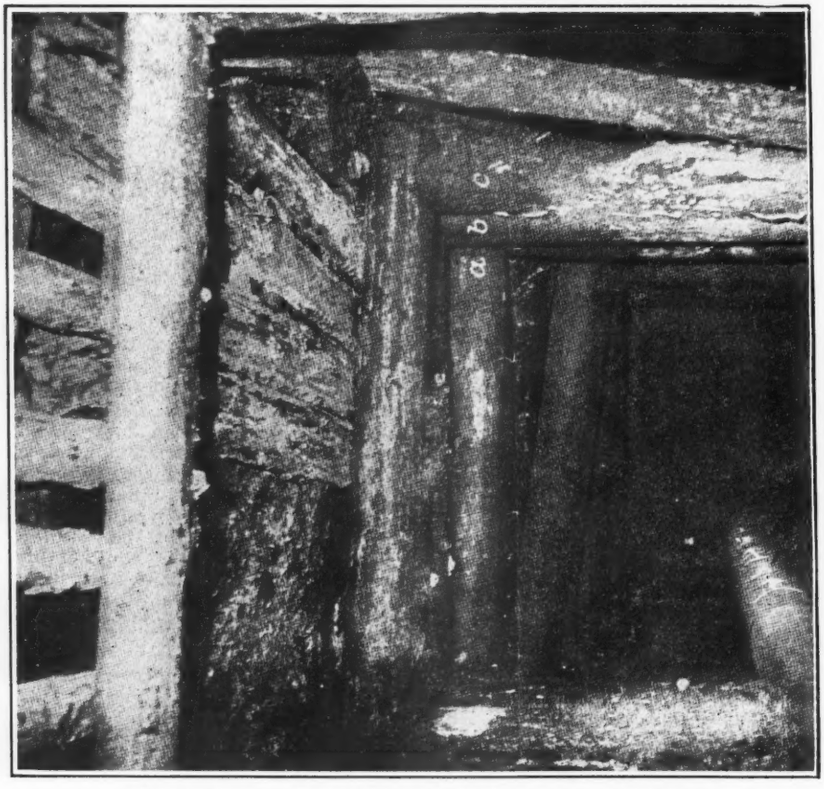
It is also quite interesting to find from often-repeated and very thorough laboratory tests that the mixture of phenols and fluorides prove inhibitive not merely at the values corresponding to that calculated from the sum of their individual toxicity, but at concentrations in many cases less than two-thirds of what would be expected.

The considerable variation in the toxic effect of straight sodium fluoride is shown in the fact that 0.10 per cent suffices to check completely development of merulius lacrymans, while for penicilium glaucum 0.85 per cent was required, and for coniophora 0.2 per cent.

Assuming for the moment the unquestioned toxicity of these salts in the proportions in which they are put into timber, the particular points of interest would seem to be, first, the demonstration of absolute neutrality, under all conditions, to iron; and, second, that the presence of dinitrophenol contributes materially to the permanent fixation of Wolman salts in the impregnated timber. The fixation of the salt in the wood fibre is such that a comparison of impregnated blocks alternately soaked in water and then dried out at about 100 deg., corresponding to hot sunlight effects, will show an appreciably greater percentage of the salts remaining in the test blocks, both in the early stages and after protracted periods, than of any other preservative heretofore used or suggested. This latter, it is claimed, is a distinctly interesting fact that has not been generally recognized.

For mine timbers, European practice has insisted upon a considerable degree of fire protection. Wolman salts contain their efficient preservative value with the addition of neutral agents to make the timber highly fire resistant.

It is not claimed that Wolmanized timber cannot be burned. The retarda-



Illustrating results obtained with different preservatives

Timbers *a*, *b* and *c* and roof timbers in foreground were treated with other materials one and a half years before photograph was taken. Timbers in background were Wolmanized and installed seven years before and do not show the slightest signs of rot.

tion is of such character as to serve every purpose in prevention of the spread of fire through timber that has been so treated. Instead of setting fire to the wood, impinging flame will do no more than char the surface to a greater or less depth according to the duration of the blast. No smoke is formed, no noxious gases are given off, no blaze results. And even the red glow of the charring wood extinguishes immediately upon removal of the external source of heat. Wolmanized timber will not support fire, will not carry fire, and is not destroyed by fire such as occurs in a mine.

Under the supervision of E. J. Clark, of Camden, N. J., tests were recently made by a large railroad system, on wood painted with practically every known so-called fireproofing paint and pieces of wood impregnated with Wolman salts. These pieces of wood were placed on a blacksmith's forge, which was blown up to its full heating capacity, and in each case wood blocks coated with fireproof paints almost instantly took fire and were entirely consumed, while results of the fire on blocks impregnated with the salts showed an entire absence of flaming or of smoke formation, and the charring extended only a little way into the block even after many minutes' exposure. After removal from the fire, it was noted that within one minute the red glow of the charred areas had disappeared, and that the blocks could be handled with bare hands. This test was made with blocks of wood 2x4x6 in. that were merely immersed in the salts over night. Similar results are unfailing when pressure treatment is first applied to the wood.

The salts are clean, healthful, and odorless, important factors in a mine preservative. They have completely replaced zinc chloride and straight sodium fluoride in German mine practice in spite of the cheapness of the latter. Creosote, though efficient as a preservative, has many disadvantages inhibiting it from general use in or even around mines.

Cost Less Than Creosote

The salts are less expensive than creosote treatment. The impregnating solution is made up in the proportion of 1.8 lb. to 100 lb. of water. The amount of solution used varies according to the different sorts of timber, ranging from perhaps 40 per cent volumetric to 20 per cent, and may be figured for ordinary cases at 12 lb. of solution per cubic foot. The cost of the impregnating material is less than 6c. per cubic foot.

The empty cell creosote process calls for nearly a gallon of creosote per cubic foot, and the full cell process double that amount, so that whether the 1925 price of creosote is taken at 14c. or at 20c. per gallon, there is a marked economy in using the salts.

The American mines and railroads that have already ordered salts cannot give as much information as is herewith submitted, based upon my extensive investigation in Europe, for the reason that the salts have been introduced into use in the United States so recently that materials the companies are treating are just being put into place.

The extensive mining operations of A. Riebeck Montan Works, Halle on the Saale, Germany, use nearly 500,000 lb. of Wolman salts yearly. Other European concerns which have had extensive experience with the salts are Rutgerswerke-Aktiengesellschaft, Hardenbergstrasse 43, Berlin-Charlottenburg 2, Germany, and Johannes Koyemann & Co., Wallhoff, Glockengiesserwell 2/4, Hamburg, Germany.

The salts are being manufactured in America by one of the largest chemical companies, and Wolmanized mine props and other lumber are treated by the pressure process at Norfolk, Va.

Trade Catalogs

Drum Filters—A very attractive cover distinguishes the new Bulletin No. 15, just issued by the Oliver Continuous Filter Co., 33 West 42d St., New York. The contents, which are equally attractive, include a description of the design, construction, and operation of Oliver continuous filters. The bulletin has been published, it is stated, to acquaint present and prospective Oliver users with the wide adaptability of the Oliver and its success in various industries. It contains fifty pages.

Hammer Drills—Bulletin 70a, issued by the Denver Rock Drill Manufacturing Co., Denver, Colo., covers the 773 series of Waugh stopers, the company's latest models of hand-rotated drills. They are made in four models: Model 773, the direct air feed dry stoper; model 773W, the direct air feed wet stoper; model 774, the reverse air feed dry stoper; and model 774W, the reverse air feed wet stoper. The catalog contains twelve pages.

Stokers—"The Condensed Catalog of Mechanical Stokers" is the title of a 32-page catalog issued by The Stoker Manufacturers' Association, of which W. V. McAllister (foot of Walker Avenue, Detroit) is secretary. The book is a complete catalog of the various competitive manufacturers of mechanical stokers. It is claimed that it is the only co-operative catalog ever published by competitive manufacturers of mechanical equipment. Copies may be had free from the secretary.

Babbitt Metals—A 12-page illustrated pamphlet has been received from the Metals Refining Co., Hammond, Ind., in which the complete sales story of the organization is given. The company makes lead oxides, plumber's lead, type metals, babbitt metals, and antimonial lead.

Roller Bearings—Bulletin No. 4,048 entitled "Allis-Chalmers Timken Roller Shaft Bearing," issued by the Allis-Chalmers Manufacturing Co., Milwaukee, Wis., shows the construction of these bearings.

Shop Press—Bulletin B-32 of the Watson-Stillman Co., 50 Church St., New York, describes a new hydraulic vertical-horizontal press which the company is making for general utility purposes.

Screen Cloth—The Ludlow-Saylor Wire Co., St. Louis, Mo., is distributing a new 157-page catalog which it claims is a complete textbook on the subject of screen cloth. It includes metric equivalents of all standard commercial designations, weights for all grades, comparative price lists for various metals, and what is claimed to be the only available compilation of woven-wire screens by openings.

Machine Tools—Bulletin 605 of the Hisey-Wolf Machine Co., Cincinnati, Ohio, describes a new friction head electric screw driver. This machine is designed with a practical disk-type friction clutch which is automatically adjusted according to the pressure applied by the operator.

Electric Motors—A folder issued by the Triumph Electric Co., Cincinnati, Ohio, is devoted to a description of the TR "Self-Start" motor. This motor, it is claimed, is the only constant speed, polyphase, alternating-current motor built in a complete range of sizes from 3 to 125 hp., and in any standard frequency voltage and speed.

Blowers, Fans—A 50-page booklet issued by the Ilg Electric Ventilating Co., 2850 N. Crawford Ave., Chicago, Ill., gives in condensed form photographs, descriptions, and specifications of the Ilg self-cooled motor propeller fans, universal blowers, automatic shutters, and Ilgair unit heaters.

Filter Plates—Norton porous plates are described in a 28-page booklet issued by the Norton Co., Worcester, Mass. These plates constitute, it is claimed, a uniformly porous acid-proof air-diffusing medium, and filter plate.

Steam Traps—A 4-page folder issued by the Armstrong Machine Works, Three Rivers, Mich., describes a new steam trap made by the company. It is intended for high pressures and temperatures.

Hoists—A new gasoline hoist made by the S. Flory Manufacturing Co., of Bangor, Pa., is described in a folder recently issued by the company.

Rotary Furnaces—New applications of the Rockwell automatic rotary furnace are described in Catalog 261, issued by W. S. Rockwell Co., 50 Church St., New York. This contains 24 pages and is entitled "Rockwell Automatic Furnaces and Quenching Coating or Coloring Tanks for Continuous Heating, Quenching, and Processing." The company will send copies on request.

Churn Drills—The Armstrong Manufacturing Co., Waterloo, Iowa, manufacturers of drilling machinery, have just issued Bulletin No. CD2, which contains a reprint of an article entitled "Churn Drill Prospecting at Morenci, Arizona," by W. R. Grunow, which was originally published in the June 3, 1916, issue of the *Engineering and Mining Journal*. The Armstrong company, is now producing an all-steel line of drills and also a patent bit-dressing machine. A complete catalog of the all-steel line is not yet ready, but several folders and leaflets have been prepared for distribution by the company, in which some of this equipment is described.

Pumps—Engineering tables containing data of use in connection with the operation of their pumps have been issued in the bulletin entitled "Pump Data 50" by the Aldrich Pump Co., of Allentown, Pa. The bulletin contains 22 pages.

The Market Report

Daily Prices of Metals

Oct.	Copper, N. Y. net refinery	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
23	13.00	51.375	51.875	8.45	8.35	6.40
24	13.125	51.50	52.00	8.50	8.65	6.425@6.45
25	13.25	51.75	52.25	8.50	8.75	6.45
27	13.25	51.625	52.125	8.70	8.90	6.475@6.50
28	13.30	51.50	52.00	8.70	8.80	6.50
29	13.30	52.25	52.75	8.65	8.75	6.50
Av.	13.204	51.667	52.167	8.583	8 70	6.463

*These prices correspond to the following quotations for copper delivered: Oct. 23d, 13.25c.; 24th, 13.375c.; 25th and 27th, 13.50c.; 28th and 29th, 13.55c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

The quotations are arrived at by a committee consisting of the market editors of *Engineering and Mining Journal-Press* and a special representative of the Bureau of Mines and the Bureau of Foreign and Domestic Commerce.

London

Oct.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
23	62 7/8	64	66 3/4	253 1/2	255 1/2	37	35	33 15/16	33 11/16
24	63 1/8	64 1/4	67 1/4	256 1/2	257 3/4	37 3/4	35 11/16	34 1/16	33 3/4
27	63 3/4	64 7/8	67 3/4	256 1/4	258	38 1/4	35 9/16	34 3/8	34 1/8
28	63 3/8	64 1/2	67 3/4	253 1/2	255	38	35 1/2	34 1/4	34
29	63 1/2	64 5/8	67 3/4	258	259 1/2	37 1/4	35 3/8	34 1/4	34 1/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Oct.	Sterling Exchange "Checks"	Silver		Gold London	Oct.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
23	4.49 3/4	70 1/2	35 1/4	92s ...	27	4.49 1/4	70	35 1/16	92s 2d
24	4.48 7/8	70 3/4	35 7/16	92s 2d	28	4.49 5/8	69 5/8	34 13/16	92s 1d
25	4.48 3/4	70	35 1/16	... ...	29	4.50 1/4	69 7/8	34 15/16	92s 1d

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter of a cent premium.

Metal Prices Continue Advance with Good Demand

New York, Oct. 29, 1924—The near approach of elections in the United States and England seems to have had no quieting influence in the metal markets, as the demand for all of the more important metals has been good all week, both here and abroad. Copper has again reached the level of early September, with all producers at 13½c. for Eastern delivery and 13⅝c. in the Middle West. Some lead was sold as high as 9c. during the week, but fancy premiums obtained on some sales seem to be at an end for the time being. Zinc has been active, both here and abroad, reaching 6½c., St. Louis. Tin sales have been good.

Copper Trend Still Upward

Conditions in the copper industry seem definitely improved, and producers feel that the advance in prices recently has been a healthy one, and not likely to be followed by another reaction below the 13c. level, as has happened so many times in the recent past. The brass companies report that orders are coming in better, and one large interest especially has assured business for the next two months in lines that have not been especially active lately. An excellent month's business has been done by the European agencies of American copper producers, and this, with a good domestic market, has put the producers in a most satisfactory position, in which they are likely to remain for several weeks at least.

Most of the selling agencies report good sales throughout the week ending today. On Thursday, the price was still generally 13¼c. delivered, but the next day, 13⅜c. was the general level; some was still available at 13¼c., but this was offset by sales in the Middle West at 13½c. A good order was placed in Detroit on Saturday as high as 13⅝c. In the last three days, practically all producers have sold copper for Connecticut valley deliveries and near-by points at 13½c., at the same time obtaining 13⅝c. from consumers further west. Sales in the Middle West have been somewhat better than usual. Most of the metal has been for November-December shipment.

Lead Now Easier to Get

The official contract price for lead, set by the American Smelting & Refining Co., was advanced from 8.25 to 8.40c. on Thursday, Oct. 23. On Saturday, Oct. 25, a further advance to 8.50c. was announced, and on Monday, Oct. 27, the present level of 8.65c., New York, was established.

Owing to the rapid advance in lead prices, producers were swamped with orders from dealers and consumers alike, only a small part of which they were able to fill. Those who had been holding lead for such a squeeze apparently found it wise to sell at around 9c., but no large amounts were taken at that level, and in the last day or two some concessions have been offered. Beginning yesterday, lead has been offered much more freely in the New York market at 8.65c., and inquiries are considerably fewer. Our St. Louis price passed that of New York during the week, the New York average being held down by the sales of the A. S. & R. at its contract level. There was also a strenuous effort to prevent a runaway market in St. Louis, but producers did not have enough lead available to stem the tide. Today, one large Middle Western producer continues to sell such lead as he has available at 8.30c., St. Louis, but the outside market is around 8.80c. As the end of the month approaches, it develops that some of the producers are likely to have more lead available than they had expected, and this will operate to ease the situation.

Conditions in lead-consuming industries are not greatly changed, but are somewhat improved. Battery manufacturers, for instance, report a gradual increase in their requirements for raw material as orders for bat-

teries for automobiles, farm-lighting plants, radio transmitters and receivers, and many other purposes continue to expand.

Zinc Firm at 6½c.

Both the domestic and export demand for zinc was highly satisfactory during the week, foreign orders being phenomenal on Friday and Saturday. Rather better prices were obtained for export, so that sellers sharing in this business were quoting somewhat above the domestic market. Producers are firm in their quotations at 6½c., which is a 10-point advance over last week. High-grade is unchanged at 8@8¼c., delivered in the East.

Spot Tin in Good Demand

The tin market was particularly active yesterday, though consumers continue interested in prompt shipment almost entirely. Today's price of 52¾c. is about one cent higher than a week ago. Supplies are almost certainly being depleted, and government stocks in the Far East cannot last much longer. Production is capable of being expanded, however. Arrivals of tin at United States ports up to and including Oct. 28 total 3,470 long tons.

Foreign Exchanges Quiet

Sterling has been firm between $4.49 and $4.50 most of the time. Closing cable quotations on Tuesday, Oct. 28, were 5.22c. for francs and 4.32c. for lire. Canadian dollars were at $\frac{1}{32}$ per cent premium.

Silver Quiet and Unchanged

Conditions in the silver market remain unchanged, with selling predominating in a narrow and quiet market.

Mexican Dollars—Oct. 23d, 53⅞c.; 24th, 54⅛c.; 25th, 53½c.; 27th, 53½c.; 28th, 53¼c.; 29th, 53⅜c.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

Aluminum—99 per cent grade, 28c. per lb.; 98 per cent, 27c. London, £125 per long ton.

Antimony—Per lb.:
Chinese and Japanese brands, 11¾c.
Cookson's "C" grade, 14¼@14½c.

Bismuth—$1.85@$1.90 per lb. London, 7s. 6d.

Cadmium—55@60c. per lb. London, 2s. 2d.@2s. 6d.

Iridium—$260@$270 per oz.

Iridium alloyed with platinum, $280 @$286.

Nickel—29@30c. per lb. for 99 per cent virgin metal. Electrolytic, 33c.; London, £160 per long ton.

Osmium—$100@$104 per troy oz.

Palladium—$83 per oz. Crude, $60@ $65.

Platinum:
Refined, $118 per oz.
Crude, $111@$112. Market inactive.

Quicksilver—$70 per 75-lb. flask. San Francisco wires $70.65; London, £11¾.

Tantalum—Metal, $350 per kg.

The prices of **Cobalt, Germanium Oxide, Magnesium, Molybdenum, Monel Metal, Osmiridium, Radium, Rhodium, Ruthenium, Selenium, Tellurium, Thallium, Tungsten,** and **Zirconium** are unchanged from the prices given in the Oct. 4 issue.

Metallic Ores

Chrome — $18.50@$24, depending upon grade and source. Nominal.

Manganese—39@41c. per long ton unit, seaport, c.i.f., for Caucasian and Brazilian ore. Nominal.

Molybdenum — 70@75c. per lb. of MoS_2 for 85 per cent concentrates. Nominal.

Tungsten Ore—Per unit, N. Y.:
High-grade wolframite, $8.75@$9.
High-grade scheelite, $9.
Ordinary grades, $8.25@$8.50.

Iron Ore, Galena and **Pyrite Radio Crystals, Tantalum,** and **Vanadium Ores** are unchanged from Oct. 4 quotations.

Zinc and Lead Still Advancing

Joplin, Mo., Oct. 25, 1924

Zinc Blende	Per Ton
High	$45.10
Premium, basis 60 per cent zinc	$44.50@$45.50
Prime Western, 60 per cent zinc	$43.00@$45.00
Fines and slimes, 60 per cent zinc	$42.00@$40.00
Average settling price, all	$41.71
Lead Ore	
High	$116.85
Basis 80 per cent lead	$117.50
Average settling price, all	$110.04

Shipment for the week: Blende, 18,792; lead, 2,415 tons. Value all ores the week, $1,049,540. Shipment for the ten months: Blende, 595,255; calamine, 372; lead, 75,983 tons. Value all ores ten months, $32,345,810.

More than 1,000 tons of blende was bought the early part of the week on $43 basis, Prime Western, but today sellers are asking $45, and it is reported a few purchases have been made on that basis. At 5 o'clock all purchase reports were not in, an indication that the demand of sellers may be accepted for a larger tonnage.

Buyers reported lead on $117.50 basis today, with sellers holding for a higher price level, which they claim on present quotations for pig lead.

Platteville, Wis., Oct. 25, 1924

Zinc	Per Ton
Blende, basis 60 per cent zinc	$45
Lead	
Lead, basis 80 per cent lead	$114

Shipments for the week: Blende, 375 tons; lead, none. Shipments for the year: Blende, 24,515; lead, 880 tons. Shipments for the week to separating plants, 1,390 tons blende.

Non-Metallic Minerals

Magnesite—Calcined, $32@$35 per 2,000 lb.

Amblygonite, Asbestos, Barytes, Bauxite, Beryl, Borax, Celestite, Chalk, China Clay, Corundum, Diatomaceous Earth, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Gypsum, Ilmenite, Iron Oxide, Lepidolite, Limestone, Manjak, Mica, Monazite, Ocher, Ozocerite, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystals, Rutile, Silica, Spodumene, Sulphur, Talc, Tripoli and **Zircon** are unchanged from Oct. 4 prices.

Mineral Products

Arsenious Oxide (white arsenic)—6¾c. per lb. Practically no market.

Copper Sulphate—4.40@4.65c. per lb.

Sodium Nitrate—$2.40 per 100 lb.

Sodium Sulphate—$16@$17 per ton, New York.

Potassium Sulphate and **Zinc Oxide** are unchanged from Oct. 4 prices.

Ferro-Alloys

Ferromanganese—Domestic, German, and English, $100 per gross ton.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferro-uranium and Ferrovanadium are unchanged from the prices given in the Oct. 4 issue.

Metal Products

Rolled Copper—Sheets, 20⅝c. base; wire, 15⅝c.

Lead Sheets—Full, 12c.; cut, 12¼c.

Nickel Silver—Grade A sheets, 18 per cent nickel, 27c. per lb.

Yellow Metal—Sheets, 18⅝c. per lb.; rods, 15⅝c.

Zinc Sheets—10.25c. per lb.

Refractories

Bauxite Brick, Chrome Brick, Firebrick, Magnesite Brick, Magnesite Cement, Silica Brick, and **Zirkite** are unchanged from Oct. 4 prices.

Iron Trade Quiet

Pittsburgh, Oct. 28, 1924

The steel market has been quieter in the last week, this being attributed to the nearness of the election. Lighter bookings in the second half of October than in the first half reverse the experience of September, which showed more activity in the second half. Bookings in October as a whole will probably run slightly below those of September, but the rate of mill operation is not appreciably affected, being between 60 and 65 per cent, where it has been since late in August.

Semi-finished steel is quotable lower, as some billet and slabs business has been done at $35.50, the market having been nominal at $37, and sheet bars can be had at $37, the nominal asking price having been $37.50. On 8,000 tons of billets $35 has been bid and refused.

Pig Iron—Two lots of 2,000 tons each of basic iron have been sold by steel interests at less than the equivalent of $19, Valley, but the sellers were outside the Valleys, and Valley producers still hold to $19. Foundry is quotable at $19.50 flat, against $19.50@$20 formerly, bessemer remaining at $20, both prices representing quotations f.o.b. Valley furnaces.

Connellsville Coke—Two sales of furnace coke, for November and for the remainder of the year respectively, have been made at little above $3. Spot remains quotable at $3@$3.10, with spot foundry at $4@$4.50. Heating and smelter grades are $2.75@$3.

Imports and Exports of Ores and Metals in September, 1923 and 1924

Imports

In Pounds, Unless Otherwise Stated

	September 1923	September 1924
Antimony		
Ore		227,560
Liquated, regulus, or metal	947,698	452,378
Copper		
Ore	9,436,482	9,716,514
Concentrates	5,638,907	1,971,823
Regulus, coarse metal and cement copper	633,968	70,682
Total	15,709,357	11,759,019
Imported from:		
Spain		631,793
Canada	3,287,889	319,724
Mexico	3,211,996	1,800,113
Cuba	3,924,044	2,560,000
Chile	4,498,094	5,939,411
Columbia		
Peru	137,072	29,871
Venezuela		
Other countries	650,262	478,107
Unrefined, black, blister and converter copper in pigs, bars, and other forms	30,379,187	27,024,684
Imported from		
Spain		1,266,570
United Kingdom	11,421	21,804
Canada	2,574,409	1,993,857
Mexico	6,198,364	4,512,257
Chile	8,236,433	8,022,886
Peru	5,634,897	3,824,548
Portuguese Africa	6,752,654	6,141,793
Other countries	971,009	1,240,969
Refined copper	2,431,811	14,878,475
Old and clippings for remanufacture	362,721	236,443
Composition metal, copper chief value	172,000	108
Copper manufactures	32,037	101,070
Brass		
Old and clippings for remanufacture	1,326,424	540,991
Manufactures of brass	62,729	87,825
Lead		
Ore and matte	2,687,189	13,431,371
Bullion or base bullion	3,578,092	12,346,031
Pigs, bars, other forms and old	279,739	12,376
Manufactures of, except type metal	45,629	19,066
Manganese ore, long tons	35,175	6,269
Pyrites, long tons	14,577	18,468
Tin		
Tin ore, tons	3	
In blocks, bars and pigs	9,799,968	11,699,148
Imported from		
United Kingdom	2,160,559	3,783,259
British Straits Settlements	6,450,514	7,822,572
Dutch East Indies	469,926	
Hongkong	584,569	70,919
Australia	22,400	22,400
Other countries	112,000	
Zinc		
Ore { Free		
Ore { Dutiable		63,180
Blocks, pigs, and other forms	5,937	1,050
Zinc dust	6,296	10,098

Exports of Copper, Lead, and Zinc

In Pounds

	September 1923	September 1924
Copper		
Ores, concentrates, matte and regulus	5,053	1,514
Copper and manufactures of	69,804,403	99,774,684
Refined in ingots, bars and other forms	63,351,539	89,819,954
Exported to		
Belgium	7,185,278	7,710,055
France	10,926,393	18,543,706
Germany	11,110,684	27,215,201
Italy	6,632,359	8,092,189
Netherlands	1,838,632	3,845,613
Spain	718,047	919,508
Sweden	2,073,757	2,858,049
United Kingdom	13,346,219	12,957,181
Canada	2,990,259	3,492,861
British India		264,205
China	3,393,600	1,852,705
Japan	2,574,936	1,657,632
Other countries	561,375	411,049
Old and scrap copper	376,693	596,761
Composition metal, copper chief value	4,837	
Pipes and tubes	286,895	248,897
Plates and sheets	320,500	615,653
Rods	4,096,315	4,896,129
Wire	456,215	1,071,601
Insulated copper wire and cable	729,766	1,081,918
Other manufactures of copper	181,643	1,443,771
Lead		
Pigs, bars and other forms:		
From domestic ore	267,122	49,716
From foreign ore	13,766,076	20,629,594

Exports of Copper, Lead and Zinc—Continued.

Exported to		
France	2,576,853	1,814,859
Germany	1,680,576	2,505,083
Netherlands	1,456,189	1,009,048
United Kingdom	5,938,898	12,233,434
Other Europe	1,176,393	817,976
Argentina	244,675	236,467
Brazil	797,763	635,434
Other countries	161,851	1,727,009
Zinc		
Ores, concentrates and dross	2,009,564	1,992,137
Zinc (spelter) in slabs, blocks or pigs	11,737,273	11,796,632
Exported to		
Belgium	559,952	112,013
France	1,499,812	1,153,763
Italy	168,081	56,010
Germany	1,086,399	1,299,579
United Kingdom	8,280,731	8,862,706
Canada	22,727	68,383
Other countries	119,571	244,178
In sheets, strips, and other forms	499,302	575,538
Zinc dust	850,465	386,854
Other zinc manufactures	56,837	96,082

World Copper Production at Same Rate as Last Year

THE copper production of the world for the first nine months of 1924 is given as 1,082,509 short tons by the American Bureau of Metal Statistics. If this rate of production continues to the end of the year, the total production for 1924 will be 1,443,348 tons. This will be approximately the same as in 1923, when the total was 1,433,102 tons, and somewhat less than during the years 1916, 1917, and 1918, when the production was 1,533,294, 1,579,675, and 1,569,523 tons respectively. The average price received so far in 1924 has been considerably less than that of last year, being 12.828c. per lb. for the first nine months, compared with 14.421c. for 1923, and 27.202, 27.180, and 24.628c. in 1916, 1917, and 1918.

The following table gives the smelter production of the various countries by months, part of the figures being estimated:

World Copper Production, 1924

In Tons of 2,000 Lb.

	April	May	June	July	Aug.	Sept.	Nine Months
United States	71,072	75,734	74,948	74,072	73,074	74,390	667,153
Chile and Peru	19,871	19,456	20,192	17,178	16,957	16,907	169,900
Belgian Congo	7,059	7,106	8,027	9,429	10,204	8,645	68,856
Europe	8,700	7,700	6,300	8,400	7,600	5,700	63,400
Japan	5,759	6,253	5,780	5,420	5,500	5,500	50,892
Mexico	3,430	3,529	2,957	2,842	2,493	2,946	28,448
Canada	2,186	2,725	2,609	2,447	1,697	1,297	19,720
Australia	849	1,507	1,052	1,691	1,662	1,192	11,956
Rhodesia	250	240	235	238	238	240	2,184
Totals	119,176	124,250	122,100	121,717	119,425	116,817	1,082,509

Maximum production was attained in May, since which time the monthly totals have been successively diminishing. United States producers apparently have not curtailed so much as South American producers; Canadian production has been cut in half.

The mine production of copper in the United States was 63,673 tons in September. Production in recent months, distributed among the various classes of producers, was as follows:

United States Mine Production, 1924, in Tons

	June	July	Aug.	Sept.	Nine Months
Porphyry mines	25,670	25,570	26,880	24,967	234,607
Lake mines	5,787	5,545	5,953	4,708	51,930
Vein mines	29,098	30,577	30,674	30,754	270,802
Custom ore	3,378	3,095	3,249	3,244	30,984
Total crude ore	63,933	64,787	66,756	63,673	588,328
Imports in ore	6,898	5,019	6,177	5,880	56,776
Blister from scrap	393	419	312	350	3,123
Total supply	71,224	70,225	73,225	69,903	648,227
Smelter production	74,948	74,072	73,074	74,390	667,153

No reduction in the output of the vein mines (excluding Michigan producers) has been made; rather, they have increased their output slightly. The porphyries and the Lake mines of Michigan, however, have curtailed.

No estimates of consumption have been issued by the Bureau, but it is generally considered that the world consumption so far this year has averaged around 7,000 tons a month above the production.

Company Reports

California Rand Silver Incorporated

Silver; Bakersfield, Calif.

The annual report of Alfred Harrell, president of the California Rand Silver Incorporated, for the year ended Sept. 11, 1924, is as follows:

Gross value of gold and silver from concentrates and ore	$1,454,106.85
Deductions for freight, treatment charges, and penalties	196,236.04
Net value	$1,257,870.81
Gross value of product for the life of the mine, including $1,900,000 from the Grady lease	$10,384,537.74
Penalties, treatment, freight	2,580,546.91
Total net	$7,803,990.83
Total dividends paid to stockholders	2,885,966.31
Surplus	407,000.00

In the last year there was a total development of 16,490 ft. The mill treated 84,808 tons of ore, an average of 233 tons per day. On actual running time, the average was 347 tons a day. The values in the feed were $17.36 per ton, the average tailing, $1.42, and the average extraction, 91.81 per cent. Litigation with the Randsburg Silver Mining Co. of Arizona has been settled, and all points in dispute are expected soon to be adjusted.

Development work has proved enough ore to keep pace with production, the assured ore being worth about $1,500,000. No new orebodies have been found on the 14th level, shaft No. 2, where exploration work is continuing, and it is the development of new orebodies which is said to be the immediate and gravest problem.

Dividend No. 55, the amount of which is not stated, was paid on Oct. 4.

Burma Corporation, Ltd.

The annual report of Burma Corporation, Ltd., for the quarter ended June 30, 1924, is as follows:

Development

Total development footage	664
Total footage in ore	321

Ore Extraction

The total number of shifts worked at the mine was as follows:	
Surface	68,542
Underground	188,086
Total	256,628

Estimated Revenue and Expenditure

		Total
Estimated gross revenue	(a) Rs.98,88,500	£659,233
Estimated operating expenditure	51,80,900	345,393
Estimated surplus over working expenditure	Rs.47,07,600	£313,840
Debenture interest	Rs.2,29,300	£15,286
Estimated income tax	5,97,700	39,846
Estimated depreciation on machinery and plant	6,48,100	43,206
Capital expenditure	11,16,000	74,400

(a) The sterling figures shown are based on the rate of exchange of Rs.15 to the £.

American Smelting & Refining Co.

A statement of the consolidated income account of the American Smelting & Refining Co. and its subsidiaries, for the first half of 1924, together with a consolidated balance sheet as of June 30, 1924, was recently issued by Simon Guggenheim, president. After deducting all bond interest, depreciation, ore depletion, taxes (including estimated federal taxes) and miscellaneous adjustments, there was a net income of $5,690,537.22, an increase of $594,491.64 over the corresponding period of last year and an increase of $1,942,534.19 over the last six months of 1923. As the preferred stock dividends for each six months amount to $1,750,000, there remained $3,940,537.22 available for dividends upon the common stock, an earning per share for the six months' period of $6.46, which is at the rate of nearly $13 per annum. There is no indebtedness to banks. At the end of the period, the company had on hand, in cash, call loans, bankers' acceptances, and government securities, $22,654,255.51, an increase of $1,816,502.81 over Dec. 31, 1923. Total surplus and reserves, amounting to $28,676,152.58, show an increase of $2,848,158.52 over Dec. 31, 1923.

Summary of Consolidated Income and Profit-and-Loss Surplus Account

	Six Months Ended June 30, 1924	Six Months Ended June 30, 1923
Net earnings of smelting and refining plants and industries immediately dependent thereon	$9,111,113.70	$8,519,898.88
Net earnings from mining properties	1,712,222.71	1,967,327.20
Total net earnings of operating properties	$10,823,336.41	$10,487,226.08
Other income—net		
Interest, rents, dividends received and commissions	659,658.04	241,145.85
Net earnings, before deducting general and administrative expenses and corporate taxes	$11,482,994.45	$10,728,371.93
Deduct		
General and administrative expenses	$682,461.50	$631,518.34
Research and examination expenses	99,601.85	71,279.41
Corporate taxes (including estimated federal taxes)	735,085.69	802,928.76
Total to deduct	$1,517,149.04	$1,505,726.51
Net income from current operations, before providing for bond interest, depreciation, obsolescence and depletion, and after providing for all taxes	9,965,845.41	9,222,645.42
Less		
Interest on First Mortgage bonds outstanding with public:		
Series "A" 5 per cent	$1,027,661.17	$1,060,330.17
Series "B" 6 per cent	289,406.20	85,985.34
Depreciation and obsolescence	2,094,296.03	2,025,811.21
Ore depletion	863,944.79	881,734.45
Miscellaneous profit-and-loss adjustment	.....	72,738.67
Total	$4,275,308.19	$4,126,599.84
Net income	5,690,537.22	5,096,045.58

Summary of Consolidated Profit-and-Loss Surplus Account

Balance at beginning of year	$17,767,785.67
Income for six months	5,690,537.22
	$23,458,322.89
Deduct dividends on	
Preferred stock	$1,750,000.00
Common stock	1,524,950.00
	$3,274,950.00
Balance June 30, 1924	$20,183,372.89

The Broken Hill Proprietary Co., Ltd.

Lead, Zinc, Steel; Australia

The Broken Hill Proprietary Co. earned a net profit for the year ended May 31, 1924, of £279,339, according to the seventy-second report of the company, recently issued. A total of £156,153 was written off for depreciation, and a further sum of £142,964 for special depreciation on mines, quarries, and miscellaneous plant.

At the steel works at Newcastle, England, continuity of operations in all departments has obtained for the first financial period since the steel works were established, 306,258 tons of pig iron being produced, and 284,669 tons of steel ingots. Underground operations at Broken Hill were resumed, and in the six and a half months of working, up to the end of the financial period, 36,392 tons of ore was produced. Ordinary milling operations in the ore-dressing mill have been suspended, and the plant is now used solely as a crushing plant; 34,862 tons of crude ore and tailings were treated and 2,158 tons of jig lead concentrates produced therein.

In the slimes flotation plant (Bradford process), 117,336 tons of slime was treated, producing 12,011 tons of lead concentrates and 25,464 tons of zinc concentrates. The zinc flotation plant was shut down in September, 1923.

After making provision for all outstanding liabilities, liquid assets in cash and convertible stocks of £1,030,684 remain, not including the company's interest in other companies. Some of the "A" and "B" series of 6 per cent debentures were redeemed during the year.

Mining Stocks

Week Ended October 25, 1924

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Alaska-Br. Col.	N. Y. Curb	...	...	*37	...	...
Anaconda	New York	37⅛	35½	36⅜	De.15, Ja.21, Q	0.75
Arcadian Consol.	Boston	1½	*95	*99	...	...
Ariz. Com'l	Boston	11	9½	10¼	Jy.19, Jy.31	0.50
Calaveras	N. Y. Curb	...	...	2	...	...
Calumet & Arizona	Boston	49½	49	49½	Se. 5, Se. 22 Q	0.50
Calumet & Hecla	Boston	15⅝	14¼	15	My. 31, Jn. 16	0.50
Canario Copper	N. Y. Curb	4	3⅜	4	...	...
Cerro de Pasco	New York	46⅞	45⅝	46	Oc. 23, No. 1	1.00
Chile Copper	New York	32¼	31½	32⅛	Se.3, Se.29, Q	0.62½
Chino	New York	20⅝	19½	20⅛	Sept., 1920	0.37½
Con. Coppermines	N. Y. Curb	3⅜	3¼	3 3/16	...	...
Copper Range	Boston	24½	23	23⅞	May, 1923	1.00
Crystal Copper	Boston Curb	*52	*45	*46	...	...
Davis-Daly	Boston	*40	*35	*35	Mar., 1920	0.25
East Butte	Boston	3¼	3¼	3¼	Dec., 1919	0.50
First National	Boston Curb	*36	*36	*36	Feb., 1919	0.15
Franklin	Boston	*65	*40	*40	...	...
Gadsden Copper	Boston Curb	*50	*50	*50	...	...
Granby Consol.	New York	18⅝	16⅞	18	May, 1919	1.25
Greene-Cananea	New York	15¼	14⅝	15¼	Nov., 1920	0.50
Hancock	Boston	1	*75	*75	...	...
Howe Sound	N. Y. Curb	2⅜	2⅛	2⅜	Ap.1,Ap.15, Q	0.05
Inspiration Consl.	New York	25⅜	24⅝	25	De.20, Ja.7, Q	0.50
Iron Cap	Boston Curb	2⅜	2	2	May, 1923	0.15
Isle Royale	Boston	16	15	15	Se. 1, Se. 15	0.50
Jerome Verde Dev.	N. Y. Curb	*96	*96	*96	...	...
Jib Consol	N. Y. Curb	*44	*31	*43	...	...
Kennecott	New York	47	45⅛	46½	Se.5, Oc.1, Q	0.75
Keweenaw	Boston	...	...	*65	...	...
Lake Copper	Boston	1¼	1⅛	1¼	...	...
Magma Copper	New York	34⅛	33⅝	34½	Jan., 1919	0.50
Mason Valley	N. Y. Curb	1 1/16	1 1/16	1 1/16	...	...
Mass Consolidated	Boston	...	...	1	Nov., 1917	1.00
Miami Copper	New York	22	20½	22	No.1 No.15 Q	0.50
Mohawk	Boston	35	31	32½	Se. 22, Oc. 13	1.00
Mother Lode Coa.	New York	7⅜	7⅛	7⅝	Jn. 13, Jn. 30	0.37½
Nevada Consol.	New York	14	13⅞	13⅞	Sept., 1920	0.25
New Cornelia	Boston	20¼	19¼	20⅛	N. 7, No. 24	0.25
New Dominion	N. Y. Curb	...	...	2⅜	...	...
North Butte	Boston	3¼	2	2⅜	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	1⅛	*99	1 1/16	...	...
Old Dominion	Boston	21½	21	21	Dec., 1918	1.00
Phelps Dodge	Open Mar.	†115	†110	...	Se.20, Oc.1 Q	1.00
Quincy	Boston	21	19	20½	Mar., 1920	1.00
Ray Consolidated	New York	12½	11¾	12¼	Dec., 1920	0.25
Ray Hercules	N. Y. Curb	...	...	*15	...	...
St. Mary's Min. Ld.	Boston	35	33	33¾	Ap.22, My.20	3.00
Seneca Copper	New York	1¾	1	1¼	...	...
Shannon	Boston	1	*90	*90	Nov., 1917	0.25
Shattuck Arizona	New York	6⅜	6¼	6⅜	Jan., 1920	0.25
Superior & Boston	Boston	1¼	1	1¼	...	...
Tenn. C. & C. cfs.	New York	8½	7⅜	8	De.31, Ja.15,Q	0.25
United Verde Ex.	N. Y. Curb	26	25⅜	26	Oc. 3, No. 1	0.50
Utah Copper	New York	82	79⅝	81¾	Se.15, Se.30,Q	1.00
Utah Metal & T.	Boston	*25	*25	*25	Dec., 1917	0.30
Victoria	Boston	...	...	*50	...	...
Walker Mining	N. Y. Curb	3⅛	2⅞	3	...	...
Winona	Boston	*40	*35	*40	...	...
NICKEL-COPPER						
Internat. Nickel	New York	20	18⅛	17⅞	Jy.17, Au.1, Q	1.50
Internat. Nickel pfd.	New York	90½	90½	90½	Oc.16, No.1, Q	1.50
LEAD						
Carnegie Lead & Zinc	Pittsburgh	...	...	2¾	...	...
National Lead	New York	156⅜	152⅜	154¼	Se.12, Se.30, Q	2.00
National Lead pfd.	New York	...	...	116	No.21,De.15, Q	1.75
St. Joseph Lead	New York	36	33¾	34	De. 9, De. 20	0.50
ZINC						
Am. Z. L. & S.	New York	8¼	7¼	7⅞	May, 1920	1.00
Am. Z. L. & S. pfd.	New York	30⅛	26⅛	29	Nov., 1920	1.50
Butte C. & Z.	New York	5⅜	5	5¼	Mar., 1923	0.50
Butte & Superior	New York	17⅜	15⅜	17	Je.15, Je.30, Q	0.50
Callahan Zn-Ld	New York	3⅝	3⅛	3⅜	Dec., 1920	0.50
New Jersey Zn.	N. Y. Curb	164¼	162⅞	163	Oc.,No.,'24 QX	4.00
United Zinc	N. Y. Curb	*25	*25	*25	...	...
Yellow Pine	Los Angeles	67	67½	67½	June, 1924	0.04
SILVER						
Alvarado	N. Y. Curb	...	...	1½	...	...
Beaver Consol.	Toronto	*18	*16½	*17	May, 1920	0.03
Castle-Trethewey	Toronto	*74	*73	*73½	...	...
Coniagas	Toronto	2.25	2.10	2.20	Ap.20, My.1	0.02½
Crown Reserve	Toronto	*52½	*49	*52	Jan., 1917	0.05
Keeley	Toronto	2.34	2.32	2.32	Sept. 15, SA	0.12
Kerr Lake	N. Y. Curb	1⅜	1⅜	1⅜	Oc. 1, Oc. 15,	0.12½
La Rose	Toronto	*8⅜	*6	*8	Apr., 1922	0.10½
Lorrain Trout Lake	Toronto	1.48	1.46	1.46	...	...
McKinley-Dar.-Sav.	Toronto	*12	*11⅜	*11⅜	Oct., 1920	0.03
Mining Corp. Can.	Toronto	2.80	2.67	2.75	Sept., 1919	0.12½
Nipissing	N. Y. Curb	6¾	6	6½	Oc.1,Oc.20,QX	0.30
Ontario Silver	New York	7	7	7	Jan., 1919	0.50
Temiskaming	Toronto	*21	*20	*20	Jan., 1920	0.40
GOLD						
Alaska Gold	New York	*12⅛	*10	*10	...	...
Alaska Juneau	New York	...	...	1⅛	...	...
Argonaut	Toronto	*32	*30½	*31¾	...	...

Stock	Exch.	High	Low	Last		Last Div.
Carson Hill	Boston	1⅛	1	1	...	...
Cresson Consol. G.	N. Y. Curb	3 1/16	3⅛	3 1/16	Se.30, Oc.6 Q	0.10
Dome Mines	New York	15	14½	14⅞	Oc.3, Oc.20, Q	0.50
Golden Cycle	Colo. Springs	1.30	1.30	1.30	My.31, Jn.10 Q	0.03
Hollinger Consol.	Toronto	14.65	14.40	14.60	Oc.16, No.3, M	0.05
Homestake Mining	New York	46	45	45	Oc.20,Oc.25,M	0.50
Kirkland Lake	Toronto	*19	*19	*19	...	...
Lake Shore	Toronto	3.94	3.91	3.93	Se.1, Se.15, Q	0.05
McIntyre-Porcupine	New York	16	15⅝	15⅞	No. 1, De. 1	0.25
Newray	Toronto	*30	*24	*28	...	...
Portland	Colo. Springs	45	45	45	Oct., 1920	0.01
Teck-Hughes	Toronto	1.20	1.14	1.18	...	...
Tom Reed	Los Angeles	23¾	23	23½	Dec., 1919	0.02
Tough-Oakes	Toronto	*53	*51½	*52	...	...
United Eastern	N. Y. Curb	...	...	*37	Jy.18, Jy.31, Q	0.05
Vipond Cons.	Toronto	1.27	1.25	1.26	...	...
Wright-Hargreaves	Toronto	3.85	3.65	3.75	Se.15,Oc.1, Q	0.02½
GOLD AND SILVER						
Black Oak	N. Y. Curb	...	...	*89	...	...
Con. Cortez	N. Y. Curb	*13	*12	*12	...	...
Con. Virginia	San Francisco	6½	4½	4½	...	...
Continental Mines	N. Y. Curb	...	...	2¼	...	...
Dolores Esperanza	N. Y. Curb	...	...	*32	Jy.1, Jy.10 Q	0.05
Premier Gold	N. Y. Curb	2 7/16	2 1/16	2 5/16	Se. 25, Oc. 30	0.08
Tonopah Belmont	N. Y. Curb	*62	*58	*58	Apr., 1923	0.05
Tonopah Divide	N. Y. Curb	*21	*21	*21	Se. 22, Oc. 10	0.10
Tonopah Extension	N. Y. Curb	3½	3½	3 7/16	Se. 10, Oc. 1	0.05
Tonopah Mining	N. Y. Curb	1⅞	1⅞	1⅞	Se. 30, Oc. 21	0.07½
Unity Gold	N. Y. Curb	1⅛	1	1	...	...
West End Consol.	N. Y. Curb	*54	*52	*52	Mar., 1923	0.05
Yukon Gold	N. Y. Curb	...	...	*50	June, 1918	0.02
SILVER-LEAD						
Ahumada	Boston Curb	6⅝	6¼	6⅜	Se.16, Oc.2, X	0.15
Bingham Mines	Boston	...	...	15½	Sept., 1919	0.25
Cardiff M. & M.	Salt Lake	...	...	*75	Oct., 1924	0.10
Chief Consol.	Boston Curb	2¾	2⅛	2⅜	Ap.19, My.1,Q	0.10
Columbus Rexall	Salt Lake	26	26	26	Aug., 1920	0.03
Consol. M. & S.	Montreal	46	43½	45½	Jn.30, Jy.15	0.75
Daly Mining	Salt Lake	...	...	2.00	July, 1920	0.10
Erupcion	Boston Curb	2½	2¼	2½	Se. 15, Oc. 2, X	0.15
Federal M. & S.	New York	10	10	10	Jan., 1909	1.50
Federal M. & S. pfd.	New York	52¼	49⅞	51⅞	Au.25, Se.15,Q	1.75
Florence Silver	Spokane	6⅝	2½	6⅝	Apr., 1919, QX	0.01
Hecla Mining	N. Y. Curb	9¾	9½	9⅞	Sept. 15, 1924	0.25
Iron Blossom Con.	N. Y. Curb	...	...	*25	Oc.25, 1924	0.02½
Marsh Mines	N. Y. Curb	...	...	*5	June, 1921	0.02½
Park City	Salt Lake	4.50	4.50	4.50	Se. 15, Oc. 1	0.15
Park Utah	N. Y. Curb	...	...	3½	Mc. 15, Ap. 1	0.15
Prince Consol.	Salt Lake	9	8½	8½	Nov., 1917	0.02
Silver King	N. Y. Curb	...	...	*50	Se. 20, Oc. 1	0.15
Silversmith	Spokane	*28	*25	*27	Oc. 1, Oc. 10	0.01
Tamarack-Custer	Spokane	1.39	1.35	1.39	Se. 22, Se. 29	0.25
Tintic Standard	Salt Lake	7.70	7.50	7.70	Se.1, '24, X	0.25
Utah-Apex	Boston	2⅝	2¼	2⅜	Se.5, Se.15, Q	0.25
IRON						
Bethlehem Steel	New York	43⅜	37¾	40¼	Jn.1, Jy.1, Q	1.25
Char. Iron	Detroit	...	...	*30	...	...
Char. Iron pfd.	Detroit	*70	*70	*70	...	...
Colorado Fuel & Iron	New York	42⅜	38½	40½	Au.11, Au.25,Q	2.00
Col. Fuel & Iron pfd.	New York	...	...	108½	Feb., 1923	2.00
Gt. North'n Iron Ore	New York	30	29	30	De.10, De.27	2.00
Inland Steel	N. Y. Curb	...	...	4	Au.5, Se.1 Q	0.62½
Mesabi Iron	N. Y. Curb	...	...	2¼	...	...
Replogle Steel	New York	11⅞	10¾	11¼	...	...
Republic I. & S.	New York	43½	42	43¼	May, 1921	1.50
Republic I. & S. pfd.	New York	83	83	83	Se.15, Oc.1, Q	1.75
Sloss-Sheffield S. & I.	New York	69	67½	68½	Se.11, Se.20, Q	1.50
Sloss-Shef. S.&I. pfd.	New York	90	88⅞	90	Se.20, Oc.1, Q	1.75
U. S. Steel	New York	108¼	104⅞	107⅞	Se.1, Se.29 QX	1.75
U. S. Steel pfd.	New York	122¼	122	122¼	Au.5, Au.30, Q	1.75
Virginia I. C. & C.	New York	37	37	37	De.15, Ja.2	1.50
Virginia I.C.&C.pfd.	New York	...	...	76	Jn. 17, Jy. 1	2.50
VANADIUM						
Vanadium Corp.	New York	23½	22¼	23⅛	Jan., 1921	1.00
ARSENIC						
Western Utah Copper	N. Y. Curb	*17	*15	*16	...	...
ASBESTOS						
Asbestos Corp.	Montreal	26	25	25	Se.29, Oc.15 Q	1.00
Asbestos Corp. pfd.	Montreal	...	...	62¾	Oc.1, Oc.15, Q	1.50
SULPHUR						
Freeport Texas	New York	9	8	8¼	Nov., 1919	1.00
Texas Gulf	New York	79½	76⅛	78⅛	Se.2,Se.15, QX	1.75
PLATINUM						
So. Am. Gold & P.	N. Y. Curb	5¼	4¼	4¾	...	...
MINING, SMELTING AND REFINING						
Amer. Metal	New York	47¼	45	47¼	Au.18, Se.2 Q	0.75
Amer. Metal pfd.	New York	112	112	112	Au.20, Se.2, Q	1.75
Amer. Sm. & Ref.	New York	79⅜	74	78	Oc.17, No.1, Q	1.25
Amer.Sm.&Ref.pfd.	New York	104⅞	104	104⅜	No.17, De.1 Q	1.75
U. S. Sm. R. & M.	New York	35¾	32¼	34¼	Jan., 1921	0.50
U.S. Sm. R.&M.pfd.	New York	45	43⅝	44¼	Oc.9, Oc.15 Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. K, Irregular. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange; Colorado Springs, Colorado Springs Stock Exchange.